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FRIDAY, MAY 20, 1898.

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A PRECISE CRITERION OF SPECIES. *

A. *The General Method.* By C. B. DAVENPORT, Harvard University.

THE aim of this paper is to propose a definite method of judging whether two closely allied and intergrading groups of organisms belong to distinct species or only to subspecies or varieties.

I. *The Present Criteria of Species.* The practical criteria employed at the present time to distinguish a species from a variety are either one of the two following: 1. A certain considerable degree of dissimilarity in characters—of divergence between the types. 2. A sharp demarcation between the types, their mutual isolation, or, in other words, the absence of intergrading forms. Of these two criteria, that of divergence is most generally employed; yet one influential body—The American Ornithologists' Union—adopts the second in a strict form. Its remarkable rule reads: "Forms known to intergrade, no matter how different, must be treated as subspecies; forms not known to intergrade, no matter how closely related, must be treated as full species." This clear cut rule does not seem however to have been worked in practice.† Nearly all naturalists, indeed, recognize a

*Read before the Boston Society of Natural History, April 6, 1898.

†See, for example, the discussion by Merriam, Allen and Roosevelt in SCIENCE, Vol. V., pp. 753, 877 and 879.

certain amount of intergrading between species. What is needed is a method of precisely defining the degree of isolation and the degree of divergence necessary for distinct species.

II. *Method of attaining a Precise Criterion of Species.* We shall accept in what follows the general opinion that the distinction between species and varieties is one of degree of divergence and degree of segregation. The question is always where to draw the line.

In drawing the line between species and varieties we must act somewhat arbitrarily, just because there is no natural division between species and varieties—one shades over into the other. We must, however, have regard to usage—recent usage, on the whole—because species have never before been studied so critically and so extensively as to-day. We must seek to define the position of the line with precision, *i. e.*, quantitatively.

1. *The General Method.* Any adequate quantitative method of studying species must start with the individual. It must recognize that a species is composed of individuals, each differing more or less in any quality from every other individual of the species. The species exist not because all of its component individuals are alike in all respects, but because in certain qualities, such as size, color or form, they tend to group themselves about a certain typical condition, which is at the same time the most frequent condition. We may call it the mode.*

Normally, this tendency for measurements of qualities to group themselves about the mode follows a very definite law. This law is the same as that followed by the deviations of a large number of rifle bullets from the center of the target at which they were aimed. It is known as the Law of Error, and is described in text-books on Least Squares. According to this law the smallest errors are the commonest; the larger ones are rarer, and the errors on one side of the mode are counterbalanced by an equal number of errors of the same size on the other side of the mode. If we lay off at equal intervals on a horizontal line a series of points corresponding to the successive classes of magnitude of an organ, and erect at each one of these points vertical lines proportional in length to the number of cases falling in that class, the curve made by joining their tops will be a normal variability curve (Fig. 1). This curve is a definite one capable of being expressed by a mathematical formula* and of being subjected to further analysis.

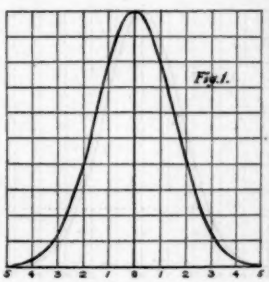


FIG. 1.

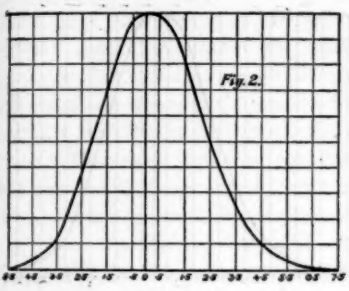
The curve will, however, vary in certain respects with each species measured. Especially will the curve vary in steepness. In some cases 50 per cent. or even more of the individuals will occur in the middle class—at the mode. In other cases 10 per cent. or even less will lie here. In the former case the curve will be very steep—the horizontal distance between the two ends of the curve, the *range*, will be small—the character is somewhat invariable or conservative. In the latter case the range of variation will be very great—the character is, we may say,

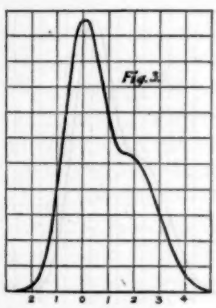
* As Professor Minot has suggested to me, 'center of variation' would be a more suggestive term. Mode has the convenience of brevity.

* The formula is $y = k.e^{-h^2x^2}$, in which k and h are constant for any curve.

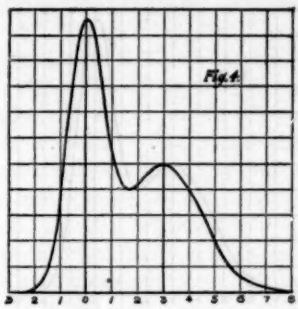
very variable. Thus the variability of any curve will be roughly defined by the range, or when the curve is symmetrical, as is usually the case, by the half-range.*

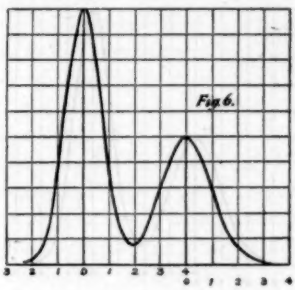
When the relative frequency of the different magnitude-classes gives us the normal curve we may be sure that we are dealing with a single homogeneous group of individuals—a species showing no tendency to break up into varieties, or a pure race. But individual measurements do not always fall into the normal curve. We may get any one of a variety of curves such as are shown in Figures 2, 3, 4, 5 and 6. Figure 2 is an asymmetrical curve. Figures

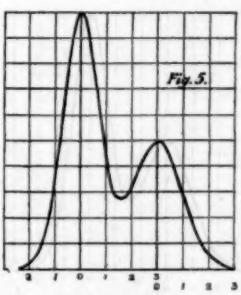




FIGS. 2, 3.







FIGS. 4, 5, 6.

* The half-range is suggested as the measure of variability on account of the fact that its determination requires no calculation. In all cases in which the curve does not end normally, but, on the contrary, includes a few highly abnormal individuals, or in cases of groups lying near the line between species and varieties, it would be best to measure divergence in terms of the 'standard deviation.' This quantity is obtained by first finding the mean of all the measurements, next getting the deviation of each class from the mean, squaring it, and multiplying it by the number of individuals in the class. Add these products, divide by the number of individuals measured, and take the square root of the quotient. These operations are briefly indicated in the formula: standard deviation $= \sqrt{\frac{\Sigma d^2}{n}}$, where Σd^2 is the sum of the squares of the deviations from the mean and n is the number of individuals. When only half of the curve can be used, find the Σd^2 and n for that half. The standard deviation is normally about one-third of the half range.

4 to 6 are bimaximal curves. All such curves indicate that the material is not homogeneous; that there is a tendency to break up into two races or species with different modes and different indices of variation.

The relationship of the two groups indicated in these curves is not equally close in all. Thus in curve Fig. 2 the two races are hardly separable. In Fig. 6 they appear as distinct, almost completely segregated species. These cases differ both in the degree of isolation and the degree of divergence of the constituent races. We need quantitative expressions for these two qualities.

The degree of isolation may be measured by the depth of the depression between the maxima. By depth of depression we mean the distance of the deepest part of the depression below the level of the lower maximum. This depth may be expressed in per cents. of the length of the shorter mode. It is clear that in Figures 2 and 3 there is no real depression, in Figure 4 one is just appearing; Figures 5 and 6 represent cases of successive increase in the depth of the depression reaching 82% in Figure 6. This ratio of the depression to the length of the shorter mode may be called the Index of Isolation.

The degree of divergence between two groups may be measured by the distance between their modes. This distance must, however, be expressed in a unit independent of the particular units employed in measuring the characters of the species. The unit must be some quality of the curve. The variability of the curve is expressed, as we have seen, by the half-range.* We may use as our unit the average of the two half-ranges of the broader curve when they are both approximately known, otherwise to its outer half-range. The divergence between the races will then be expressed as the ratio of the distance between the modes to the half-range,* or thrice the standard deviation, of the broader curve. This may be called the Index of Divergence.

These two indices, however, are not independent but are curiously bound together. Thus if two equal, symmetrical curves with the same variation overlap so that the inner end of each curve just touches the mode of the other—in other words, when the Index or Divergence, is 100, the Index of Isolation will be found to be about 56. If the curves are of very different area or form, the Index of Isolation may be, with the Index of Divergence still at 100, diminished, but where large numbers are used it will rarely, in practice (provided the curves are symmetrical) be less than 50.

The question arises whether it would not be necessary to draw curves for many characters. Practically it will not be necessary, for confluent species are usually separated chiefly by one most distinctive character. This character may be termed the *chief differential*. It may be used alone to measure the isolation and divergence of the groups, to test their specific value.

Again, how are the individuals which are measured for the differential to be selected? They must be taken methodically at random. This sounds paradoxical, perhaps, but it is not. One takes methodically at random when one lays a yard stick on a grass plot and plucks those blades which lie nearest the inch divisions, or gathers field mice from traps set in a straight line at distances of one mile apart, or at the angles of hundred-mile rectangles, and so on. The individuals measured are rigidly taken on some other basis than their own characters. It will not, of course, always be possible to have individuals gathered so rigidly at random. This is only the ideal which can rarely be realized.

In plotting results the actual and not the percentage frequency of each class should

* Or thrice the standard deviation.

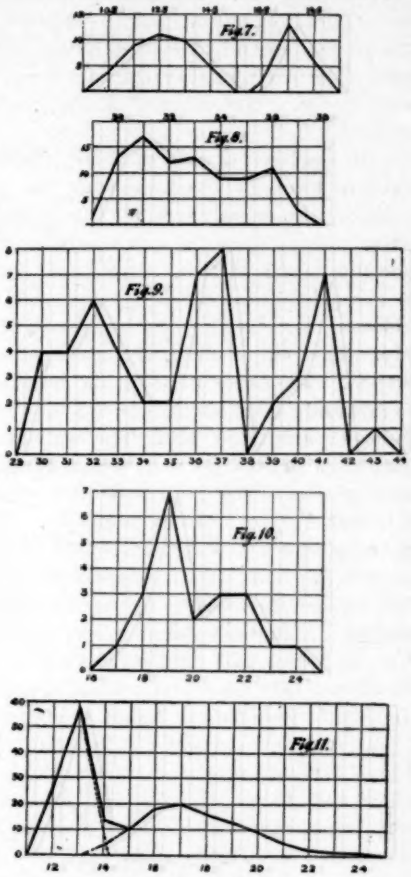
be given. One of the two groups indicated may have many fewer individuals than the other. Very good; this is an important fact which the curve should be left to show.

To sum up: The general method of attaining a precise criterion of species, as opposed to varieties, is to measure the chief differential of the groups, plot the curve of measurements showing the relative number of cases in each class of measurements and determine the index of isolation, or, if more convenient, the index of divergence. If either of these indices is less than a certain number we have varieties; if above that number, species.

2. *Determination of the Line between Species and Varieties.* The question now remains: What is this number below which we have varieties, above which species? To determine it we must, as we have said, have recourse to the usage of systematists.

Let us consider first a clear case: Fig. 7 is formed from measurements of two species of jumping mouse, *Zapus hudsonius* and *Zapus insignis*. 80 individuals of each species, from New Brunswick, New Hampshire, Massachusetts and New York, were measured by Mr. G. S. Miller,* from whose work the data are taken. The two species occur in the same localities. *Zapus insignis* differs from *Z. hudsonius* (1) in having longer ears, (2) in being paler and more fulvous, and (3) in being larger. Numerical data are given on characters (1) and (3) only. These show the length of ears to be the chief differential. Plotting the length of ears, disregarding the very slight sexual differences, we see that there is an absence of intergrades. The index of divergence is 200; that is, the distance between the modes is twice the average distance of the ends of the broader curve from the mode.

Secondly, we have in Figure 8 a curve of three undoubted varieties. The curve is based on measurements of 130 individuals of *Scalops aquaticus*, the Eastern mole, from data furnished by True.* The moles were



FIGS. 7, 8, 9, 10, 11.

collected from (1) the Atlantic and Gulf Slope, (2) the Mississippi Valley as far south as Louisiana, (3) Texas and Oklahoma. In different parts of its range the species shows differences in length of skull and in the form of the coronoid process of

*G. S. Miller, Jr. A Jumping Mouse, *Zapus insignis*, Miller, new to the United States. Proc. Biol. Soc. Washington., VIII., 1-8, 1893.

*F. W. True, A Revision of the American Moles. Proc. U. S. Nat. Mus., XIX., 1-112.

the lower jaw. Data are given on length of skull, which we assume to be the chief differential. Plotting these data (Fig. 8) we find that they form one curve with, however, three maxima. The index of isolation between the first and second modes is 8%; between the second and third 18%. The curves from each locality overlap the adjacent modes. The index of divergence is less than 100.

Again we have a case of three alleged species of the mole *Scaphanus* from the extreme northwestern part of the United States. The differentiæ are size of body, color and length of face. Numerical data are given by True on skull length which is closely correlated with the size of the body. The curve (Fig. 9) gives three maxima. The index of isolation between the first and second maxima is 66; between the second and third, 100. The end of the constituent curves do not overlap the adjacent modes. The indices of divergence are about 170 and 130 respectively. We may admit these as distinct species.

Again the hare, *Lepus palustris*, varies in different localities chiefly in the breadth of the face. Miller and Bangs * from a study of eight individuals concluded that there were two species which they called *L. palustris* and *L. paludicola*. Later Chapman † concluded from a study of nineteen individuals from the same localities as those of Miller and Bangs that the two forms are only varieties. Which view is correct? Plotting (Fig. 10) the ratio *greatest nasal width*, basilar length of skull, we find that the index of isolation is 33, the index of divergence is 70. These forms are no doubt varieties.

A case from fishes: Two species, *Leuciscus balteatus* and *L. hydrophlox*, from the Columbia River basin differ in the number of rays in the anal fin. The mode of these two groups is different, but an overlapping occurs. Are not these groups perhaps varieties? (Fig. 11.) The index of isolation is 50%; that of divergence is 100%. The case is a doubtful one. We are near the limit between species and varieties.

Additional examples from mammals, birds and fishes might be given, but those already considered may suffice to illustrate the method by which a conclusion as to where the line should be drawn has been reached for animals. The conclusion is that when the chief differential of any two groups shows an index of isolation of 50% or more, or when their index of divergence is 100% or more, the two groups are species; otherwise they are varieties.

B. *The Chief Differential and Specific vs. Individual Characters.* By J. W. Blankinship, Harvard University.

In the previous part of this paper a method was shown for the determination of the value of species by means of the isolation and divergence indicated by the chief-differential. In this will be considered the determination of the chief-differential itself as the most marked of the specific characters, and also the mathematical discrimination of specific and individual characters.

I. *Determination of the Chief-differential.*

Necessarily all the specific characters are considered in the determination of species, but these characters are of different values and their variation from one species into the other is never strictly correlative, hence systematists in the case of critical intergrades are compelled to separate the species by a single character in order to ensure uniformity in their determinations. That character is taken which is most distinct in the two species and exhibits correlative variation with the other, minor, specific characters. That most distinctive character is

* Proc. Biol. Soc. Wash., IX., 1894.

† Bull. Amer. Mus. Nat. Hist., VI., 341, 1894.

here called the chief-differential. Now it is frequently the case that different systematists working in the same groups select different characters as the most distinctive, and consequently, as the characters are not perfectly correlative, the specific line is drawn at different points. For instance, one botanist may separate *Thalictrum purpurascens*, L. from *T. polygamum*, Muhl., by the characters of the leaf, another by the form of the stamens; one distinguish *Callitriche verna*, L. from *C. heterophylla*, Pursh by the persistence of the stigmas; another by the shape of the fruit. It is necessary then to have a method for determining the chief-differential in order that the specific lines be uniformly drawn and that the value of the species be justly estimated. The method for obtaining the chief-differential may be shown by taking a particular case.

Two species of the marsh plant *Typha* are found in the eastern United States and are often confluent at the point where the brackish marshes pass into fresh-water swamps. Seven characters regarded as probably specific were measured in about 250 specimens taken mainly from eastern Massachusetts and selected one meter apart, as nearly as possible, across the swamps were found. These seven characters were each arranged separately by classes, according to size and the relative frequency of each class enumerated, as shown in the following table:

TABLE OF RELATIVE FREQUENCY.

(Fig. 12.) I. STEM-HEIGHT, measured from the ground or water to base of Pistillate Spike.

Decimeters.	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
No. of Individuals.	2	2	6	8	18	30	33	**38**	**38**	27	18	16	7	2	2

(Fig. 13.) II. BASE DIAMETER OF STEM, including leaf-sheaths.

Millimeters.	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
No. of Individuals.	2	20	**45**	21	19	4	10	13	17	**19**	16	13	5	5	2	1

(Fig. 14.) III. MID-STEM DIAMETER, taken at half the height.

Millimeters.	2	3	4	5	6	7	8	9	10	11	12
No. of Individuals.	5	10	**68**	43	29	**31**	25	23	11	2	1

(Fig. 15.) IV. LEAF-WIDTH, largest leaf in widest part.

Millimeters.	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
No. of Individuals.	12	26	**39**	25	15	6	5	14	11	16	15	**20**	15	12	7	8	1	1	0	2

(Fig. 16.) V. PISTILLATE SPIKE-LENGTH.

Centimeters.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
No. of Individuals.	1	0	5	7	9	17	23	22	**37**	**37**	26	23	12	11	6	3	7	1	0	0	1	0	0	1

(Fig. 17.) VI. PISTILLATE SPIKE-DIAMETER.

Millimeters.	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
No. of Individuals.	1	7	3	6	6	12	13	**30**	29	19	3	5	2	10	6	6	16	8	**17**	15	5	10	6	3	1	1	1

(Fig. 18.) VII. INTERVAL between Staminate and Pistillate Spikes.

Centimeters.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of Individuals.	**110**	15	7	16	37	**40**	9	4	2	0	1	1	0	0	0	1

From the table above we may collect the following data:

	Total Variation.	Modes at	Minimum of Sinus.	H'ght of Lower Mode.	Index of Isolation	Divergence of Modes.	Greater Half-range.	Index of Divergence.
Stem Height.	7–21 dm.	14–15 dm.	..	..	..	.....	.....	....
Base Diam.	6–36 mm.	10 & 24mm.	4	19	79	14 mm.	12 mm.	116
Mid-Diam.	2–12 "	4 & 7 "	29	31	7	3 "	5 "	60
Leaf-Width.	4–23 "	6 & 15 "	5	20	75	9 "	8 "	112
Spike Length.	3–26 cm.	11–12 cm.	..	..	.	.....	.....	....
Spike Diam.	9–35 mm.	16 & 27mm.	2	17	89	11 "	8 "	137
Interval.	0–15 cm.	0 & 5 cm.	7	40	83	5 cm.	10 cm.	50

Of these seven characters the stem-height and the spike-length show no apparent differentiation for the two species; the differentiation is slight in the mid-stem diameter, but is marked in the other characters. Both isolation and divergence are greatest in the spike-diameter, which therefore should be taken for the chief-differential. The isolation being above 50 per cent. (89) and the divergence above 100 per cent. (137), both are undoubtedly good species.

Taking those characters showing marked differentiation, the modes indicate the most frequent form of the species, the smaller size being *angustifolia* and the larger *latifolia*, and hence represent the *specific types* of those species as they occur in this region. This specific type must not be confused with the *historical type*, which is the form of the species first described and may occur at any point within the normal limits of the variation of the species.

II. *Specific and Individual Characters.*

In order to make the enumeration of differentiæ accurate it may be necessary in the discrimination of species to determine which characters can be regarded as specific and which as individual. Those characters are called specific which differ in some respect in the two species and whose difference increases or diminishes correlatively with that of the chief-differential. Any variable character in the two species not exhibiting such correlation is regarded as individual.

In order to determine this fact of correlation, these same characters of *Typha* were compared with the spike-diameter as subject. The average stem-height, base-diameter, leaf-width, etc., was found of all specimens having a spike-diameter of 8 mm., the same of 9 mm., 10 mm., and so on up to 36 mm. Correlation is then shown by the character having a proportional increment or reduction in size in comparison with the chief-differential, the spike-diameter. The result is given in the table below.

From this it appears that the correlation with the spike-diameter is well-marked in the case of the base-diameter, the mid-stem diameter and the leaf-width. It is apparent in the stem-height and spike-length, yet is not so close as to give rise to two modes in the table of frequency. The case of the interval is peculiar. In the table of frequency it exhibits a combined normal and half Galton-curve, while in the table of correlation above, there is little increase or decrease in the first ten numbers (good *angustifolia*) and the subsequent decrease is probably due to intergrading. This character then exhibits individual variation for this species.*

*Of the other characters of *Typha* not here considered, the pollen-grains might possibly prove a better

TABLE OF CORRELATION.

No. Measured.	Spike Diam. mm.	Stem Height cm.	Base Diam. mm.	Mid-Stem. Diam. mm.	Leaf Width mm.	Spike Length cm.	Interval mm.
1	8	115	9	2	4	7	50
3–5	9	100	8	2	3	8	43
7–10	10	100	8	2	4	7	69
5–6	11	105	10	3	5	8	57
11–15	12	110	9	3	4	7	58
11–12	13	124	11	4	5	7	44
23–34	14	117	11	3	5	11	53
29–36	15	130	11	4	6	10	49
46–57	16	140	11	4	6	11	50
37–41	17	141	12	4	7	12	43
30–35	18	173	15	4	8	12	37
15–16	19	153	16	5	10	12	15
18–20	20	169	19	6	11	13	8
7–10	21	153	17	6	10	11	13
36–38	22	168	18	6	11	13	7
22–28	23	163	17	6	10	14	5
24–27	24	158	19	6	11	13	6
33–34	25	155	21	7	13	13	3
17–18	26	159	22	7	13	11	2
33–37	27	168	23	7	14	13	1
23–27	28	170	23	7	15	13	1
9–12	29	175	22	9	15	13	0
15–21	30	172	24	8	15	13	1
11–12	31	162	24	7	14	13	0
6	32	167	24	8	15	13	0
1–4	33	184	23	8	17	11	4
2–3	34	205	25	8	19	18	0
1	35	167	27	9	15	13	0
1	36	142	26	7	13	10	0

A normal curve of variation extends an equal distance on each side of its mode, and hence in a dimorphic curve composed of two such normals the continued extension of the interior curves below the point of confluence may be determined approximately by reference to the exterior halves. In the curve of the spike-diameter (Fig. 17) this overlapping portion of the curves of *latifolia* and *angustifolia* (19–23 mm.) represents the region of intergrades between those two species. Also, the minimum of the sinus (21 mm.), where occur the fewest intergrades between the two species, is the point where systematists would naturally separate them.

It has now been shown that confluent species can be separated by a fixed amount of isolation and divergence, as indicated by their most distinctive character—the chief-differential, which can be determined mathematically by the measurement of all the specific characters; and finally, a method has been indicated whereby specific and individual characters may be distinguished by correlation.

It should be remembered that the measurement of individuals of a species, selected impartially after a fixed method throughout a given region, gives the characteristics of that species—its type and variation, the

differential than any of those measured, but their extremely short duration (about two weeks in the year) and their microscopic size do not render them generally available for systematic work. From my observation of *Typha* in this region, I do not think the color of the spike or shape of the stigmas are reliable as differentials between these two species, and the floral bracts are doubtfully absent in *latifolia*, becoming gradually larger through the intergrades to typical *angustifolia*.

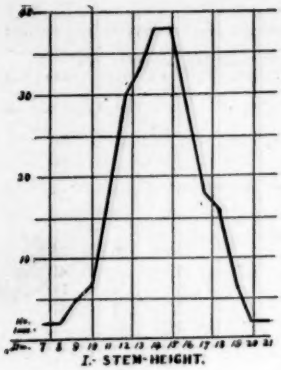


FIG. 12

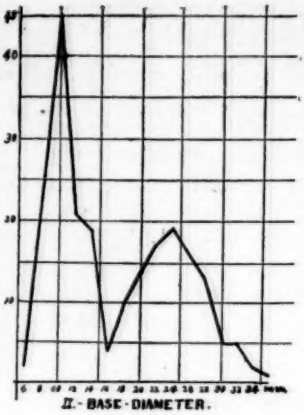


FIG. 13.

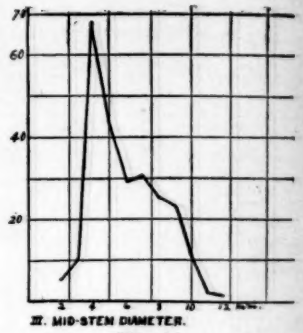


FIG. 14.

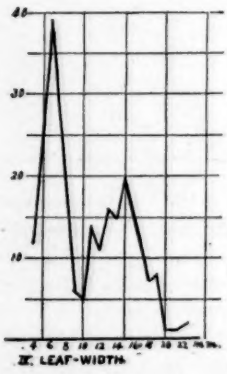


FIG. 15.

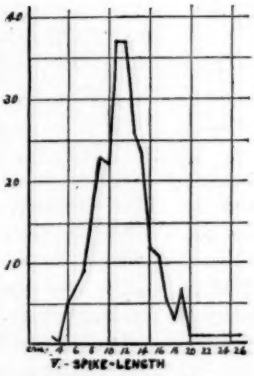


FIG. 16.

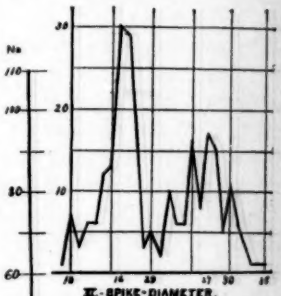


FIG. 17.

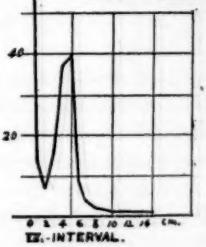


FIG. 18.

relative abundance of its forms and its confluence with allied species—only for that region. For the complete determination of its true characteristics the species must be studied throughout its entire range. This can often be done approximately by the study of a large collection representing the various parts of that range, as is now done in ordinary systematic work. However, two groups found to be so isolated and divergent as to constitute distinct species in any one region where their ranges or specific factors overlap will doubtless be found to continue distinct in all parts of their ranges, as the greatest confluence of such groups is necessarily at points where they occur together.

This method attempts only to express in mathematical terms the facts already recognized by systematists in the discrimination of species; it attempts to determine, by impartial quantitative enumeration of individuals, the specific type and the limits of specific variation, as well as the relative

value of the species or variety, and this more accurately than can be done by the ordinary descriptive terms. The discrimination of species has hitherto been dependent upon the experience and judgment of each systematist, and consequently the results have often been most conflicting and confusing. By the use of a precise mathematical criterion of species 'splitting' and 'lumping' is no longer possible and any hybrid or intergrade, which may have been described as a species or a variety, is clearly shown by its intermediate position and by the absence of isolation, while a sport is indicated by its relative fewness of individuals and its place at the extreme of variation.

The possibilities of statistical methods in the study of individual variation extends far beyond the applications here proposed. The gradual change of the specific type and of the variability of a species, the distinguishing of stable from plastic groups, the influence of environment upon specific form, and many other matters of importance to the philosophical naturalist and systematist, are in the future to be investigated quantitatively.*

JULIUS SACHS (II).

IT was at Würzburg that Sachs first found fit opportunity to develop his talent for teaching. Too often it happens in lecture-rooms that '*man Viele sieht, die nicht da sind*,' but this did not apply to him. His fascinating, lucid expositions stimulated the students, whilst he knew well how to practically illustrate his subject. He worked incessantly at the materials for demonstrating, drew and painted a number of diagrams, and was constantly adding to his stock of dried plants, alcohol preparations, models and cultures. He considered that all should be in due relation to the subject-matter in a scientific lecture as in the acting of a play. In the winter he lectured on general botany (anatomy and physiology), and in the summer on the 'Natural History of the Plant World.' Besides this he often gave experimental demonstrations in the summer and this necessitated a great deal of work; occasionally he lectured on the history of botany and on the physiological basis of morphology. After 1874 he had a class every term for microscope work.

A great number of botanists worked at one time or another in his laboratory. The first were Dr. Kraus and Millardet (both formerly at Bonn and Freiburg). Among others attracted by him to Würzburg were Baranetzky, Brefeld, Francis Darwin, Detlefsen, Elfving, W. Gardiner, Godlewski, Goebel, Hansen, Hauptfleisch, Klebs, H. Müller-Thurgau, Moll, Noll, Pedersen, Pfeffer, Prantl, Reinke, D. H. Scott, Stahl, Vines, De Vries, Marshall Ward, Weber, Wortmann and Zimmermann. He insisted upon his pupils being in earnest about science, and he brooked no laziness. Weak natures naturally felt his influence most strongly, but he set a higher value on those from whom he could gain something.

With failing health he withdrew more and more into himself. "I am beginning to take private pupils again," he writes, "but there is little pleasure in it. When a professor reaches the age of sixty he ought *eo ipso* to be pensioned off with his full salary; it might be possible to arrange a university that would serve as an almshouse, but I would not go into it."

He urged his pupils to make comprehensive studies even as he was constantly striving after wide generalizations. He was a master in the art. We have only to

*Those who desire further information on the quantitative study of species are referred to the excellent paper of Dr. F. Ludwig: 'Die Pflanzlichen Variationscurven und die Gauss'sche Wahrscheinlichkeitscurve,' in the Botanisches Centralblatt, 73: 241, 1898.

think of his 'Experimental Physiology,' his 'Text-book' in four editions, his 'History of Botany' and his 'Lectures on the Physiology of Plants.' Although he wrote with ease, he bestowed great care upon composition, and usually made several rough sketches before the work was done to his satisfaction. In later years he generally dictated, and the 'Lectures' were written in this way. The great debt owed by modern botany to his 'Text-book' can scarcely be appreciated even yet by the younger generation of botanists.

No entirely satisfactory text-book had appeared since Schleiden's 'Outlines,' a book that contained much that was critically suggestive, but, on the other hand, was one-sided and tinged by the author's personal prejudices; nor had the later editions of it been brought up to date with the advance of science. Sachs' book was the first to make Nägeli's and Hofmeister's researches known to the world. It was written in an unusually clear, literary style, and contained all that was best according to 'the present state of science,' as the title page says, especially the author's important physiological researches. The letter-press was interspersed with numerous illustrations, chiefly Sachs' own work and not seldom the results of laborious, tedious experiments. These illustrations have been frequently reproduced and, contrary to Sachs' express wish, have become common property. Too often it has been considered quite unnecessary to obtain his consent to the use of the figures, and the appearance of a newer text-book decked out with his own illustrations elicited from him the somewhat bitter though just remark that a student, using this book, would surely think that he (Sachs) was employed by the author to illustrate his work. Towards the end of his life the frequent revisions needed for a text-book became a burden to him; he could not make up his mind to a fifth edition and he wrote his 'Lectures' in a freer style of exposition.

The book, however, that presents the best insight into Sachs' individuality is his 'History of Botany.' Nägeli had originally been commissioned to undertake this work, which was to form a part of 'The History of Science in Germany,' issued by the Royal Academy of Bavaria, but he had soon abandoned the task. It cost Sachs five years' continuous toil. As with all human work, it has many defects and omissions, but the lucidity, the profound philosophical bent of Sachs' mind, lend an incomparable charm to the whole. An English translation of this work appeared in 1890.

If I further attempt briefly to characterize Sachs' importance with respect to science it is with a due sense of the difficulties of the case. His activity was so comprehensive, the results of his researches have become, through his 'Text-book,' so largely common property that it is not easy briefly to set forth what he has done for science. One would have to write a history of botany from 1860 onwards to justly rate his services. But this is by no means the place for such a work, nor do I feel equal to the task. The extracts already given show that he was no one-sided physiologist, and he was fully aware of the fact. "It may surprise you," he writes, "that from my boyhood the mysteries of relationship (systematic botany) have interested me more than those of biology and physiology. I have apparently specialized in the last-named branch of science, because I have always been of the opinion that the ultimate problems of systematic botany can only be solved by physiological methods." His latest treatises most clearly reveal what he meant.

De Bary's remarks with respect to Mohl apply more or less to almost all distinguished investigators ('Bot. Zeitung,' 1872, p. 572): "As regards a number of dis-

coveries for which we are indebted to Mohl, his claims to priority in them may justly be disputed if this expression be taken to denote the pretension to have first seen or spoken of a thing, * * * the lucid, confident recognition of it is, however, due to Mohl's observation." But in Sachs' case the remark applies not merely to the observation of facts, to which Mohl confined himself, but to bringing into prominence the importance of such facts in their relation to the common stock of our knowledge, and to the right ordering of observations in the general building of knowledge—work on which he laid great stress. He writes: "As I read your book I feel anew how much more merit there is in working out a comprehensive subject from reliable sources, and from a higher standpoint, than in constantly supplying fresh contributions, which, however meritorious in themselves, are yet as the scattered stones of the hillside compared to milestones pointing us on our way!"

Sachs is best known and most famous as the founder of the modern physiology of plants, and his physiological works may be next touched upon. "My earliest treatises," he once wrote, "were composed at a time when the physiology of plants was simply non-existent; I myself was entirely self-taught and consequently much of my work was imperfect, especially the manner of exposition." Nevertheless these earlier works are of great importance. Next to be named come his works upon chemical philosophy. The investigations of Ingenhouss, Th. de Saussure, Liebig, Boussingault and others had supplied the foundation upon which, in connection with the results of plant-anatomy, a more exact knowledge of the phenomena of metabolism was to be built up. It was Sachs who first pointed out "that the starch in chlorophyll is not merely a secondary deposit, but must be regarded as the product of the assimilating activity (produced by the action of light) of the granular, chlorophyll substance; that it is formed in the chlorophyll out of its original elements, and is conducted to the growing buds and to the tissues which store up the reserve material"*—a brilliant addition to our knowledge, the fundamental importance of which needs hardly to be demonstrated at the present day.

The formation of starch largely engaged his attention later on. He contrived a simple means of quantitatively estimating starch-assimilation, and by the application of the 'iodine test' to leaves or portions of leaves, respectively, supplied an extraordinarily simple and instructive method of demonstration.

His services in improving the culture of plants in nutrient solutions are well known. They drew down upon him a violent attack from Knop which deeply wounded him, and not without reason. It is now one of the most elementary experiments in the physiology of plants to rear a plant from germination to seed-bearing by the administration of nutrient salts, but at that time it was maintained that the seed-bearing plants of maize must have been placed in the solution of nutrient salts after they had attained a flourishing condition!

He incidentally discovered the interesting fact that polished marble slabs may be corroded by roots—a fact of some importance for the understanding of the functions of these organs. He began to work upon entirely virgin soil when, at the close of his fiftieth year, he set on foot investigations which brought to light by microscopical tests, and above all by microchemical methods, the movements, chemical changes, and final consumption of the reserve material during the growth of organs. These experiments have also proved of fundamental importance, and he lays stress upon the fact that they served first to lead him to think

* 'Collected Essays,' p. 335.

that the chlorophyll grains are the true organs of assimilation. A bare reference must suffice to the classical treatises on the germination of the date-palm, of grasses, or on inulin, etc.

In later years he ceased to contribute experimentally to our knowledge of metabolism. Other problems had meanwhile claimed his attention. His investigations—the first to be made—into the action of heat claim special notice. The phenomena of freezing had long been in need of investigation, and here also Sachs' work created a clear conception of the problem and went far towards clearing it up. Even more important were 'The Physiological Experiments upon the Dependence of Germination on the Temperature.' For by these the law of the 'drei Kardinalpunkte' (three cardinal points) was established, and the term 'Optimum' introduced for one of them—a name that has been adopted in other departments of science. These experiments were carried out with the simplest appliances not even in a botanical laboratory, but in his own rooms at Prague. His great manual dexterity and skill in devising simple, but extremely effective, instruments were most useful to him.

The discovery that with sensitive organs there are temporary conditions of rigor due to heat and cold has become an intrinsic part of physiology, whilst the establishment of the fact that not only light, but at the same time a sufficiently high temperature, is needed for the formation of cholorophyll in the higher plants was of great interest.

From amongst the series of researches grouped together in the *Gesammelten Abhandlungen* (*Collected Essays*) under the heading 'The Action of Light' I should like shortly to refer to the treatise 'Upon the Influence of Daylight on the Production and Development of Different Plant-organs.'

The fact that the formation of cells and organs is dependent upon light was submitted in this paper for the first time to a searching investigation; it was shown that the formation of roots was in many cases directly favored by light; the conclusion was drawn from Wigand's data that with fern prothallia light determines the dorsiventrality, and the phenomena of etiolation, which still present many enigmas, were more closely examined. The investigation into the action of light through the medium of the foliage-leaves upon the formation of flowers was especially important to Sachs, because it formed the starting-point for his later theory of 'Matter and Form.' It showed him that plants, such as *Tropaeolum*, *Brassica*, etc., continue to produce etiolated stem-parts and leaves in darkness "in sufficient quantity for the production of fresh blooms if this depended only upon the bulk of the material stored for the purpose and not also upon the particular quality of it," a fact that later led him to form his theory as to the specific matter out of which organs are formed. The formation of blossoms was proved to depend directly or indirectly upon light, inasmuch as by the assimilating activity of the leaves in light the materials destined to produce flowers are formed. Later research into 'The action of the ultra-violet rays upon the production of flowers' seeks to define this phenomenon more closely.

The action of colored light upon plants in respect to assimilation and to their heliotropic curves, etc., received soon after valuable confirmation. Sachs introduced the simple and convenient method of counting the bubbles given off by water plants in light, and came to the conclusion (which lately has again been questioned) that the so-called chemical rays have very little to do with the giving off of oxygen.

A keen controversy was aroused by the opinions he formed in consequence of his researches into 'The movements of water in plants.' But even if his inbibition

theory be rejected it must not be forgotten how many valuable facts are due to his activity in this field. The effects produced by the chemical and physical state of the soil upon transpiration, the checking action of salt solutions, low temperatures, etc., were well established; the 'Lithium Method' was used for measuring the rate of the transpiration current; and the profound and far-reaching importance of transpiration for the life of most plants was demonstrated.

A further laborious and protracted series of experiments dealt with the phenomena of growth and of movements produced by stimuli. Among the more notable of these are the construction of the first auxanometer, the graphic description of his observations, and the recognition of the grand period of growth. His investigations into the growth of the main and side roots first proved convincingly the factors which condition the regular extension of the root system in the ground, and established the distribution of growth in roots, as well as the correlation between main and side roots. A number of isolated observations are also to be found in this exhaustive treatise. Sachs' clear, perspicuous style renders it a pleasure to read any of his essays, even when he is compelled to enter minutely into detail.

The phenomenon of 'Hydrotropismus' (the name originated with Sachs) had already been occasionally investigated, but Sachs showed it to be due to irritability, demonstrated its importance and facilitated the examination of it by a simple apparatus. The 'Hängende Sieb' (hanging sieve) is now to be found, like the auxanometer and the klinostat, in every botanical laboratory.

The 'Tropisms' (Heliotropism, Geotropism, etc.) made large demands upon his time and attention. When under Hofmeister's influence, as regards experimental physiology, he inclined to an external, mechanical conception of these, but abandoned this later. His own words best denote his standpoint: "I, too, should have nothing to say against the term 'Lebenskraft' (vital force), and have indicated as much from time to time in my 'History of Botany,' but the word has been spoilt and rendered nugatory by misuse. I say, therefore, to denote my conception of the organic world, that the province of true physiology begins where that of mechanics, physics and chemistry of organisms ends. Indeed, I go farther and maintain that the time will come when in physiology will be found the ultimate basis (what Goethe speaks of as 'die Mütter') of all natural sciences." There is no need to say that this vitalistic view did not prevent him from working out with the deepest interest the phenomena of growth-curvatures. He also established the phenomenon known as 'after-effects,' and contributed many other valuable isolated experiments.

If he attached great importance to theories, he was fully conscious of their transitory nature; and I might mention, as an example of this, that in his later years he did not lay so much stress upon his theory of Heliotropism. There will be more to say about this when reference is made to his treatise on orthotropic and plagiotropic organs.

In the meanwhile attention must be directed to the essays upon the connection between cell-formation and growth, which in my opinion belong to his most brilliant achievements. As a result of Nägeli's researches on the apical cell, numerous botanical works had arisen dealing with the laws of cell-division. It was this tendency, exaggerated until it was justly dubbed 'Zellfängerei,' that led men to neglect plants and organs as a whole for the mere cells, and to take it as granted that growth is determined by the manner and method of cell-division, much as the shape of a building

is determined by the way the building-stones are laid one upon another.

Hofmeister's brilliant, though hardly well-grounded, opposition had but little success; only a few botanists took any notice of it. It was Sachs who, in his usual clear manner and by the aid of simple contrivances, first explained the relations between cell-disposition and growth. In his opinion the latter is the determining factor, the arrangement of cells depending upon growth. This explained why, for instance, cross-sections through cylindrical masses of cells in plants belonging to widely separated groups may present the same appearance of cell-arrangement as a developing alga or a hair of a dicotyledon. The introduction of the terms 'anticlinal' and 'periclinal' made a brief, striking bird's-eye view of the matter possible, and facilitated further study of the changes in cell-disposition occurring during growth. A large group of facts was brought together under a common heading, and not only was the way made smooth for further investigations into the causes of the arrangement of cells, but an important point of departure was also made for experiments on the evolution of organs which do not possess an apical cell.

The changes which had gradually taken place in the cell theory have led to an entire alteration in its original meaning. This prompted Sachs, who always felt the need of clear and consequently historically correct conceptions, to introduce the definition '*Energid*.' In my opinion he thereby rendered good service to science. It was a great satisfaction to him that his achievements found favor with the most eminent histologists (Kupffer, for instance), and this consoled him for the fact that the botanists, now as on other occasions, instead of testing the innovation in its general application, sought only too zealously for instances in which it did not apply. But the time will surely come when it will be deemed absurd to describe a *Caulerpa*, for instance, as a 'unicellular' plant, and it fell to Sachs to fit scientific nomenclature to recent advances in knowledge. It was self-evident to him that definitions are only a means towards generalization and that they have absolutely no validity in themselves.

The essay upon orthotropic and plagiotropic plant-parts takes us into a region that lay nearest to Sachs' heart during the last years of his life, namely, that of physiological or causative morphology. In this treatise he deals with the connection between the structure (in the widest sense of the word) and the direction of the organs. The definitions 'orthotropic' and 'plagiotropic' were introduced, and referred more particularly to the dorsiventral structures that had long been neglected under the supremacy of the 'spiral theory.' He does not merely treat of the purely structural conditions, but of the causative relations between orthotropic growth and dorsiventral structure. Sachs would, I believe, have altered later his theoretical conclusions upon plagiotropism; they are based upon ideas which he no longer held, as we may see in the text, to be as thoroughly warranted as formerly. But putting aside these points, about which opinions still differ, we find ideas in this essay that are still working with considerable effect in morphology.

As a morphologist Sachs' activity displayed itself in one direction by some special studies that date from his earlier years, in another by his text-books, and again by his final general essays.

His two treatises, on Collema* and Crucibulum, show him at work in the region of cryptogams. It was he who in his 'Textbook' defended Schwendener's Lichen

*In this essay he approached very closely to the later lichen theory when he said that it looked as if a parasitical fungus had established itself in the nostoc; he believed that the nostoc-heterocysts might develop into a mycellium.

theory at a time when the cautious De Bary (in his criticisms of the second editions of the 'Text-book') looked askance at it. The Archegoniates are treated in the 'Text-book' with special interest, forming part, as they had done, of his own researches. His grouping of thallophytes (in the fourth edition of the 'Text-book'), which met with such adverse criticism, has at any rate attained the satisfactory position of being approached again in our own days by many writers.

Throughout his life he cared little for those details that often fill men's lives, and preferred to view matters from a wide and general standpoint. In the first edition of his 'Text-book' he had set his face against 'idealistic morphology' at a time when it was dominant, and in a paragraph of his 'History' that promises to become classical he laid bare the foundations upon which this tendency rested.

Darwinism was another bugbear to him and he intended to attack it vigorously in the 'Principles.' "As far as it goes I am delighted to be free from 'the immutability of species' and to be able on good grounds to accept evolution. But it is absolutely uncertain *how* we are to conceive of this latter. Therefore, I say that the natural system of classification is only to be explained by descent, but how *this* is to be explained no one knows. I regard descent as a fact, like gravitation, about which also we are absolutely in the dark." His whole conception of the world rebelled against 'the crude materialism' which he thought he found in Darwinism. "If my 'Principles' do not meet with the response I had expected, they have done me good service in showing me that Darwinism as a whole is entirely superfluous for any scheme of the final causes of nature. A superfluous theory has received its sentence."

He sought, however, to obtain some similar conception of causes by his theory of 'organ-forming matter,' which caused the external diversity of organs to appear dependent upon their material differences of substance, a view which had its origin in the researches alluded to above on the dependence of bud-formation upon the assimilation activity of the leaves. By this a theoretical basis was gained for experimental morphology; deformities, galls, etc., could be referred to definite changes of substance; and the assumption that stem-forming substances find their way to the point of stem-growth, root-forming to that of the root-system, explained to him most naturally the facts to be seen in reproduction. It is evident that in such a difficult subject one must look for sketches, or general views, rather than theories worked out in detail. But at any rate Sachs' views are more fruitful than Nägeli's 'Idio-plasma,' and he made a number of experimental morphological studies on their bases.

He had already arrived at the conception of the continuity of the embryonic substance before the appearance of Weismann's 'Germ-plasm.' "That which has maintained itself alive, and has continually reproduced itself since the beginning of organic life upon the earth, moving steadily onward in the eternal change of all structures, in the unvarying alternation of life and death, *that* is the embryonic matter of vegetation, and it is this which in certain cases differentiates itself into the two sexes in order again to unite."

He conceived of the multiplicity of plant forms as arising, on the one hand, from the phylogenetic morphological differentiation (this, however, he regarded as an 'absolute mystery'), and on the other from the reaction of the common vegetable substance in response to external stimuli (automorphosis and mechanomorphosis). 'Adaptation' in Darwin's sense of the expression he considered entirely superfluous, and herein he was in entire agreement with

Nägeli. He expressed his views in a powerful manner in his last writings—the physiological 'Notices'* published in 'Flora.' The manuscript found after his death, entitled 'The Principles of Vegetable Formation,' has been handed over to Professor Noll for publication.

This slight sketch can give but an inadequate idea of Sachs' life-work, with its abundant results as regards science; indeed, I can but liken what I have written to a man striking, one by one, a few strings of an instrument that has answered to the touch of some great musician.

One may well say with the Psalmist in speaking of his days:

"Yet is their strength but labor and sorrow."

Nevertheless his life has borne rich fruit; his name is forever bound up with the history of botany. He has enriched this science by the discovery of new and important facts and conceptions and by his unrivalled power of clear definition. In the nature of things it is impossible that all his theories should retain acceptance, but they have all profoundly influenced his contemporaries. There is no doubt that in any other calling Sachs would have risen to the first rank; eccentricities and narrow 'specializing' were alike repugnant to him. In the last years of his life he applied himself eagerly to paleontological and zoological studies. "I must be learning, always learning," he wrote in a letter. In spite of his incessant labors, he was one of the few men of the present day who possess the gift of letter-writing and withal a spirited style, clear and trenchant. And yet these letters, written during the last fifteen years of his life, form one long report of illness.

At last Death, who in the latter years had often drawn very near, took him gently by the hand and led him to his final rest.

K. Goebel.

*These will shortly appear as a separate publication.

THE BREEDING OF ANIMALS AT WOODS HOLL DURING THE MONTH OF APRIL, 1898.

The temperature of the water has remained above the average almost throughout the month. During the first week the thermometer registered 41 F. to 42 F.; during the last week, 45 F. to 46 F. The specific gravity has varied from 1.0231 to 1.0235. The weather has been generally cloudy and the temperature of the atmosphere low.

Vertebrates. — The winter flatfish, *P. americanus*, ceased spawning early in the month, and, though the height of the breeding season was in March, few of the young flatfish have been taken, even over the natural spawning grounds. Young sculpin (*A. æneus*) were very abundant in the tow, especially during the first of the month. On April 4th a very large number were captured, and many were taken on the 18th. On the 27th a few more were taken which apparently had just hatched. Small cod and pollock have been frequently captured, and the latter were more numerous than in March. The young of the sandlaunce (*A. americanus*) have diminished in numbers but little since last month, though some have increased considerably in size. On the 17th an unusually large number were taken. The young of the fall herring (*A. harengus*), from three-fourths of an inch to three inches in length, have appeared in increasing numbers. A few specimens of *Ctenolabrus* were examined on April 19th, but the sexual glands, though quite large, were not nearly mature. *Petromyzon* has been taken in the fish traps, and may be seen frequently in the markets.

Crustacea.—The small species of *Gammarus*, abundant in the tow during March, are still breeding. Their appearance, from day to day, is uncertain. One day there may be only four or five in the net, and the next day hundreds may be captured. A

small species of *Mysis*, about one-half inch in length, has been abundant, and the brood-pouches have been filled with eggs or embryos. A larger species, bearing well developed embryos, was abundantly taken during the first two or three weeks. The red copepod, the favorite food of the young cod, sculpin and sand launce, has been present in great numbers. A few were caught at every haul of the skimming-net, and frequently great numbers were taken. Their sudden appearance and disappearance is very puzzling. Dr. Loeb has shown that in the aquaria they are positively or negatively heliotropic, according to the temperature, but I find that when first transferred from the surface-net into a dish a large minority become negatively heliotropic, though, of course, all are subjected to temperature of the ocean. Many other species of copepods were caught, though not in great abundance. Some were bearing eggs attached to the abdominal appendages. A small parasitic copepod is very frequently found attached to the young cod, sand launce and sculpin. Perhaps one-third of these fish are thus infested. The *isopod* (*Cirolana concharum*) was not breeding on April 26th, and the associated *amphipod* had apparently passed its breeding season. *Hippa* has not begun to lay, though the ovaries are full of large brilliantly-colored eggs. They have been found breeding in July.

Vermes.—No *Nereis virens* or *Nereis limbata* have been seen at the surface. *Autolytus*, with egg-clusters attached, were regularly taken in the tow, usually three or four at a time, during the earlier portions of the month. Later in the month only a few were noticed. An interesting species of *Syllis* has been taken from among the hydroids and algæ on several occasions. These annelids are in almost every case about to undergo fission. The new head is found in all stages of development in the midst of the trunk metameres. The eyes on the new head are large and brown, while those on the first segment are small and black. These annelids are full of mature eggs, which, in some instances at least, occupy the body-cavity both in front of and behind the new head. A light, cream-colored terebellid, full of eggs, has been taken from time to time, and was also taken during March. It is almost invariably present in clusters of the hydroid *Parypha*, along with one or two species of *Caprella*, *Eolis* and the little gasterpod *Astyris*. *Harmothoe* sp. has commonly been found under stones and among hydroids, laden with beautiful pink eggs, which show clearly through the body-wall. On April 11th the eggs, teased from the body cavity, were easily fertilized, and in less than two hours some had reached the eight-cell stage; specimens taken April 17th were also full of eggs. The common *Lepidonotus* has been laying during the last two weeks. *Cirratulus grandis*, collected at Ram Island, April 9th, and at Pine Island, April 17th, contained great numbers of eggs, apparently nearly ripe, though an attempt at artificial fertilization was not successful. Some of the spermatozoa were motile, but the male worms did not have the bright orange color which characterizes them in the height of the breeding season, early in July. Sagitta, though numerous, has been less abundant than in March. The specimens are much larger than those found during the summer months, and are filled with eggs. During the last week there has been a notable decrease in their numbers, and small individuals, less than one-half inch in length, have been frequently noted.

Mollusks.—A few egg-strings of *Sycotypus* and *Fulgar*, containing well-formed shells, have been taken at various localities along the shore. *Urosalpinx* has not begun to breed. Young 'veligers' of *Crepidula for-*

nicata were found in the egg-packets on April 6th and on April 17th, though specimens with young are not frequent. The eggs of a small gasteropod abounded on the stems of *Parypha* during the entire month. Five species of nudibranchs, belonging to the genus *Eolis*, have laid their eggs in the aquaria. The hermaphrodite gland of *Eolis papillosa* contains giant erythrophilous spermatozoa, like those of *Paludina vivipara*, which Auerbach has described. Eggs of *Ilyanassa* were found April 25th and 27th. The 'sand collars' of Natica were found at Hadley Harbor, April 25th.

Echinoderms.—*Echinorachnius parma* has not been examined since the early part of the month, when it was breeding abundantly. On April 16th the plutei, developed from eggs fertilized on March 22d, were still living in the aquaria. Eggs of this species have also been obtained in June and July. It is a remarkable fact that, though neither *Asterias vulgaris* nor *Asterias forbesii* at Woods Holl contain ripe sexual products, those of the latter species in certain parts of Narragansett Bay have been full, almost to bursting, of eggs and spermatozoa since the early part of April. The holothurians *Thyone*, *Leptosynapta giradii* and *L. roseola*, were examined April 24th, and were all full of nearly ripe eggs or sperm. Not the least attractive of the echinoderm eggs are those of the little starfish, *Cribrella sanguinolenta*. This species is not uncommon at Woods Holl, and the eggs, which were frequently laid in the aquaria during the third week in April, are as large as those of *Clepsine* or *Sycotypus*. They develop slowly, reaching the two-cell stage in about 6 hours. This material would undoubtedly be of great value in solving problems of cleavage and of echinoderm metamorphosis.

Cœlenterates.—The profusion of cœlenterate material was a feature of every collecting excursion during the first half of the month. Hydromedusæ of many different species were abundant in the tow until about the 17th of the month, and since then have been caught in small numbers. Among these, *Hybocodon* was perhaps the most numerous, although *Coryne* and *Tiaropsis* has been taken frequently. *Tima formosa*, abundant in 1897 at Newport, has not been seen. Hydroids of the brilliantly colored *Coryne* occurred in colonies that could be measured by the square yard, and those of a species of *Campanularia* could be measured by the square rod. On April 26th the *Coryne* had disintegrated. The large jellyfish, *Cyanea arctica*, has been represented throughout the month by specimens ranging from one-half inch to seven and eight inches in diameter, and *Ephyræ* were caught as late as the 21st. On April 8th the water at Waquoit was full of *Aurelia*, most of the specimens being from one to two inches in diameter, though some were much larger. *Metridium marginatum* was examined on the 18th, and was found to be full of eggs, apparently nearly mature. One of the 'sulphur sponges' was observed to extrude clouds of spermatozoa on April 10th.

The gelatinous alga, so abundant during March and the first half of April, gradually diminished in quantity after the 17th, and on April 25 little or none was found in the nets.*

A. D. Mead.

CURRENT NOTES ON PHYSIOGRAPHY.

THE ORIGIN OF PUGET SOUND.

The long fiords of the submerged mountainous coast of Alaska and British Columbia naturally give rise to the impression that Puget Sound and its many branches in Washington are also drowned valleys. This off-hand interpretation is combated in an essay on the 'Drift phenomena of Puget

* The Breeding of Animals at Woods Holl for the month of March was published in 'Science,' April 8, 1898.

Sound,' by Willis (Bull. Geol. Soc. Amer., IX., 1898, 111–162), who after a study of the region concludes that it was invaded by confluent glaciers from mountains on the north, east and west, and that the spaces between the ice streams were built up by washed drift. Plateau-like land-arms were thus constructed with relatively even upland surfaces and smooth marginal slopes, while the glaciers held possession of the troughs. When the glaciers melted away, the troughs came to be occupied by arms of the sea. Lateral moraines along certain of the troughs prove that they antedate the latest epoch of glaciation, and are not channels of post-Pliocene erosion. The greater depths of certain troughs some distance in from their outer end does not accord with the idea that they are drowned valleys of stream erosion. Since the disappearance of the ice, alluvial deposits brought down by the larger rivers have formed delta flood plains in a number of the troughs, such as those of Duwamish and Puyallup valleys, by Seattle and Tacoma.

THE PLAINS OF RUSSIA.

DAS RUSSISCHE FLACHLAND forms the subject of an interesting sketch by Philippson (Zeitschr. Gesell. f. Erdk. Berlin, XXXIII., 1898, 37–68), from which the leading features of that great region may be easily gathered. Paleozoic strata, nearly horizontal and but moderately indurated, rest upon a crystalline floor that appears on the northwest and southwest; Mesozoic and Tertiary strata overlap irregularly, chiefly from the southeast. Bevelling far and wide across these varied formations stretches the upland plain of comparatively even surface at an altitude of 200–300 meters. The northwestern part of the plain is heavily covered with glacial drift, through which the bed rock is seldom seen; the southern part has a loess mantle, which overlaps the border of the drift. The former is the region of forests; the latter, of steppes; the 'black earth' being a modification of loess by the superficial addition of humus. The plain beneath these discrete covers is described as a gigantic 'denudationsflache,' the result of the lateral shifting of great rivers when the land stood lower than now; and the question is raised whether the floods from melting ice fields may not have supplied the great rivers. To-day the plain is dissected by narrow valleys of branching streams, and from this an uplift is inferred subsequent to the peneplanation.

The insular position of Great Britain has been recognized by British geologists and geographers as giving rise to an over-estimate of the relative value of marine as compared to sub-aerial denudation. May not the relatively modern block-dislocations of the uplands and mountains of Germany, where many areas of resistant rocks are included, and where an advanced stage of base-levelling has not been reached in the present cycle of erosion, have given rise to an under-estimate of the competency of normal rivers to produce peneplains. Such general denudation is aided truly enough by the lateral shifting of the larger streams, but it is accomplished chiefly by the slow weathering of the inter-stream hills. Does it not hurry the slow processes of penultimate denudation to imply that they may have been accomplished in so brief an episode as a glacial period, and by so temporary an agent as the floods from a melting ice sheet?

TIDAL PROBLEMS.

THE difficulty of accounting for the actual tides of the oceans, in contrast to the ease of explaining the lunar and solar forces to which they are due, is well set forth in an inaugural address 'Ueber Gezeitenwellen,' by Krümmel, on his accession to the rectorate of the University of Kiel (Ann. der Hydrog., XXV., 1897, 337–346). Among

the special features mentioned are the following: The tide wave advances progressively from south to north on the west coast of Europe, but arrives simultaneously along a great stretch of eastern North America. It advances northward on the east coast and southward on the west coast of New Zealand, but arrives all at once on the eastern coast of Australia over a belt covering 26 degrees of latitude. Spring tide is delayed from half a day to two and a-half days after new moon at most Atlantic stations, but at Toulon, on the Mediterranean, it occurs $4\frac{3}{4}$ hours before the syzygies. The diurnal inequality, which should reach its maximum with the greatest declination of the moon, is belated on the European coast by from four to seven days, while at one point in the Gulf of Mexico it is accelerated by 17 hours. Much consideration is given to Boergen's discussion of interfering waves, whereby the notable differences between the tides of oceanic islands may perhaps be accounted for. The once-a-day tides on lunar time in the Gulf of Mexico and on solar time at Tahiti and elsewhere are thus to be explained. The studies of George Darwin and Lord Kelvin in the modifications suffered by the tide waves when running ashore have shown that 'overtides,' having shorter periods than normal tides, may be thus produced, and these are compared with the overtones of musical sounds, as explained by Helmholtz. The three tides in a day in the Tay at Stirling, Scotland, and in the harbors back of the Isle of Wight are thought to be of this nature. The continuous records of tide gauges reveal an increasing number of stations at which waves of short periods, from 5 to 90 minutes, are found, the shortest of these being much longer than the longest period of wind-made swell (12 to 15 seconds). Some of these oscillations, as in various arms of the Mediterranean, are probably to be compared with the seiches of lakes. W. M. Davis.

CURRENT NOTES ON ANTHROPOLOGY.

31ST PEABODY MUSEUM REPORT.

The thirty-first report of the Peabody Museum of American Archæology and Ethnology describes the progress of its explorations and collections. Those in Central America were continued under the care of Mr. George Gordon. He examined various caves but did not find in them any objects of great antiquity. The collections of casts have been enlarged, but there remains much which the museum could do in this line if it had more funds. Mention is made of the liberality of the Duke of Loubat, of Miss Breton and others. Miss Whitney has given to the Museum the famous 'Calaveras skull,' together with the objects found around it. The general activity indicated by the Report continues to reflect the highest credit on the curator, Professor F. W. Putnam.

THE AIMS OF ETHNOLOGY.

A suggestive address was recently delivered before the Batavian Society of Arts and Sciences by Professor Bastian, who is making a prolonged journey in the Orient. His subject was 'The Purposes of Ethnology.' The style is simpler than is usual with this celebrated master, and his matter is highly suggestive. He emphasizes the principle that ethnology concerns itself only with man as a social being, and that he derives all his worth from the others with whom he lives. The elementary thoughts of savage tribes should occupy our first attention. From these we should trace the ethnic modifications which arise in the course of development. They stand in close relation to geographic conditions, which are always the leading factors in ethnic evolution. These thoughts are well brought out in Professor Bastian's address.

THE ARAUCANIAN TONGUE.

The twenty-first volume of the Library of American Linguistics, published in Paris,

is taken up with a comprehensive grammar and dictionary of the native language of Chili, called by some the Araucanian, but in this instance the Auca. The author is Mr. Raoul de la Grasserie. His treatise occupies 372 pages and embraces a large number of texts. To these he adds a literal translation and a grammatical analysis. His previous studies on American languages and on the philosophy of language in general guarantee his accuracy and thoroughness. He has used the moderately abundant writings of previous scholars with judgment, and throws new light on several points heretofore obscure in the construction of the tongue. (Langue Auca, Paris, 1898, J. Maisonneuve.)

D. G. BRINTON.
UNIVERSITY OF PENNSYLVANIA.

NOTES ON INORGANIC CHEMISTRY.

AT a meeting of the Institution of Civil Engineers (Great Britain) held March 15th Mr. Henry Fowler read a paper on 'Calcium Carbid and Acetylene,' which summarized the present knowledge of the subject. From the full abstract in *Nature* we note the following: As the power theoretically required to produce one pound of calcium carbid in the electric furnace is more than 2 H.P. hours, its manufacture is at present restricted to localities where power is cheap, as, for instance, where water-power is available. The acetylene flame has a high actinic value, and causes light colors to appear lighter and dark colors darker than when exposed to sunlight. The gas, when inhaled, combines with the hemoglobin and renders the blood incapable of taking up oxygen; it is no more dangerous, however, in this respect than coal gas. With calcium carbid at $80 a ton, acetylene can compete with coal gas at 62 cents per thousand feet, where flat flames are used for the latter, and a light of not less than 30 candles is required. It is now used for lighting a station on the Great Southern and Western Railway of Ireland, and at the Salford Docks of the Manchester Ship Canal. Its price prevents its use for gas-engines. It cannot be used economically to enrich coal gas, as with low percentages the increase is not above 1 candle-power for 1 per cent. acetylene. With water gas it is even less applicable, as more than 10 per cent. is required before any illumination is obtained. Methane and nitrogen are claimed to carry the gas without affecting its illuminating power.

THE subject of the Watt Memorial lecture, delivered March 11th at Watt Memorial Hall, by Professor Thorpe, was 'James Watt and the Discovery of the Composition of Water.' The honor of this discovery, which is one of the landmarks of the history of chemistry, has been shared by Cavendish and Lavoisier, but Professor Thorpe shows that Watt, whose connection with the discovery has been generally regarded as incidental, in writing to Priestley, April 21, 1783: "Are we not, then, authorized to conclude that water is composed of dephlogisticated (oxygen) and inflammable (hydrogen) air or phlogiston deprived of part of their latent heat," was the first, as far as we can prove from documentary evidence, to state distinctly that water is not an element, but is composed, weight for weight, of two other substances, one of which he regarded as phlogiston and the other as dephlogisticated air. It was on June 25th following that Lavoisier announced his discovery to the Academie des Sciences, while Watt's letter to Priestley was published with another letter of his in in the *Philosophical Transactions* as having been read on April 29, 1784. In reality, however, Watt antedated Lavoisier more than two months.

THE rare element gallium has been found by Professor Hartley and Mr. Hugh Ramage to be very widely distributed in the earth

and also in meteoric bodies, as has already been noticed in these notes. It, therefore, appeared to be of interest to determine if it is present in the sun. A paper on this subject has been read by these authors before the Royal Dublin Society. The first problem was to determine with great accuracy the wave-lengths of the principal lines in the spectrum of gallium. This was accomplished by photographing the spectrum of gallium with the 21.5-feet radius grating spectrograph in the Physical Laboratory of the Royal University of Ireland. The wave-length of the two principal lines was found to be 4,172.215 and 4,033.125. In Rowland's map of the solar specrum 4,172.211 is given as an aluminum line and 4,033.112 as not identified. As gallium is present in every bauxite and shale and every specimen of aluminum examined by the authors there is no doubt that this line should really be attributed to gallium and not to be aluminum. Gallium must, therefore, be added to the list of elements known to occur in the sun; which only emphasizes the widespread occurence of this element in nature.

J. L. H.

SCIENTIFIC NOTES AND NEWS.

CIVIL SERVICE EXAMINATIONS IN SCIENCE.

Two important scientific positions are to be filled under the Smithsonian Institution, by examination, on June 7th.

One of these is that of Assistant Curator, Division of Mammals, U. S. National Museum, with a salary of $1,500 per annum. Competitors will be rated in the elements of education, experience, publications and thesis, which will be weighted 10, 15, 50 and 25, respectively. Applicants will be furnished with the subject for the thesis, and with special forms upon which it is to be submitted. The Department states that it is desirable that persons certified for this position shall be men not less than 25 nor more than 40 years of age, and that they should possess a good general education (college graduates preferred); a general knowledge of zoology, and a thorough knowledge of mammalogy, more especially as relating to the North American fauna; they should have a practical knowledge of field-collecting, and of museum methods of preserving, arranging and labeling collections.

The second vacancy is in the position of Physicist, for special work in connection with the Astrophysical Observatory, Smithsonian Institution, at a salary of $1,000 to $1,200 per annum. This examination will consist of the subjects below, which will be weighted as follows:

General physics,	7
Physical laboratory training,	5
Treatment of observations,	2
Mechanical drawing,	2
French,	1
German,	1
English,	2
Total,	20

MUSEUMS OF THE SCIENCE AND ART DEPARTMENT, LONDON.

The Select Committee appointed to inquire into and report upon the administration and cost of the Museums of the Science and Art Department have agreed to the following first report:

Since the issue of the report of the Museums of the Science and Art Department Committee in July, 1897, your committee have continued the inquiry, but reserve for a further report the publication of additional evidence with their final review and recommendations.

They feel, however, bound to report without delay certain conclusions at which they have arrived, on consideration of the evidence, as regards the South Kensington Museum and the Geological Museum in Jermyn-street.

They are unanimously of opinion that with a view to present efficient management, to economy of administration, to future development of the collections, and to their full use for the purpose of exhibition and of instruction, it is necessary:

1. That the whole area on the east side of Exhibition-road (except that occupied by the Royal College of Science, which cannot be sacrificed except at great cost) be exclusively devoted to the Art Museum and the Art Library,

with provision for the conduct of the business connected with Loans of Art Objects and the Art Schools. They are satisfied that the whole of this space is required for the Art Schools, the due exhibition of the Art Collection and the administration connected with such a museum.

2. That provision for the whole of the Science Collection, the Science Library, for Loans of Scientific Objects and for the Science Schools be made on the west side of the Exhibition-road.

They are convinced that this concentration of Art on one side of the road and of Science on the other is essential to good administration, to satisfactory results from the money expended, and efficiency both in the museum and in the schools. This arrangement would allow space for the future development both of the Art and of the Science branches.

They also unanimously recommend that the Geological Museum in Jermyn-street be no longer occupied for the same purposes as now, and that the collections there exhibited be removed to the west side of Exhibition-road and made part of the Science collections.

OBSERVATORIES ON THE AZORES.

As we have already stated, the Prince of Monaco, on April 29th, brought to the notice of the Royal Society the project which he suggested to the British Association in 1892, of establishing a meteorological station on the Azores. As reported in the London *Times*, he said its objects, as he conceived them, were the observation of certain atmospheric disturbances apparently formed in this region, and the correction of the path assigned to others that are announced from America at too great a distance of time and space for there to be any assurance that their strength and direction may not be considerably modified before they reach European coasts. He pointed out that at such an observatory the study of seismic phenomena could be advantageously carried on, because in certain circumstances earthquakes felt in Europe had previously affected the Azores. Moreover, in the study of terrestrial magnetism, being situated in mid-ocean, it could render useful service, for the increasing use of electricity for lighting and traction was making it more necessary that magnetic observations should be carried out in very remote places. Observations made on the Azores would benefit many countries directly, because they interested all branches of the nautical profession as well as the populations of the western coasts of Europe. Since the scheme was first mentioned, in 1892, an event which he had awaited with much impatience had, the Prince said, arrived to help it, and that was the establishment of telegraphic communication between the Azores and Europe. Soon after this was done the Portuguese government gave effect to his views by setting up on the Island of San Miguel, under the direction of Captain Chaves, a regular meteorological station, which, however, was most modestly equipped. Finally, last year Captain Chaves was commissioned to establish on the Island of Flores, the most westerly of the Azores, a second station whose observations would usefully supplement those of San Miguel. Unfortunately this was even poorer than the other, and was not yet reached by the telegraph cable. In order that science might the sooner profit by the advantages promised by this observatory, and in order to guard against interruption of its functions, he proposed to give it a constitution founded on the principle of an international guarantee to be secured by the pecuniary contributions of the countries concerned. He suggested that this arrangement might be carried out by the various countries bearing the expense of the particular class of observation in which each was interested. One, for instance, might support observations on magnetic phenomena, another on those of the winds, and so on. Portugal, accepting the principle of an international *régime*, had commissioned Captain Chaves to invite the maritime nations concerned to give their adhesion to the project and to associate themselves with the organization of this meteorological service. It might, therefore, be hoped that in the near future an understanding would be arrived at as to the development of the observatories on the Azores, and he asked the Royal Society to use its great influence in the domain of science for securing the accession of England to the ideas he was upholding.

GENERAL.

Professor George H. Darwin, of Cambridge, England, was elected a foreign honorary member of the American Academy of Arts and Sciences at its meeting of May 11th, in place of the late Professor J. J. Sylvester.

Professor Nicholas Senn, of Chicago, has been appointed Assistant Surgeon-General of the army with the rank of Lieutenant-Colonel.

Professors Metchnikof and Roux, of Paris, have been elected honorary members of the Imperial University of Kieff.

The council of the Institution of Civil Engineers, London, have made the following awards for papers read and discussed before the institution during the past session: Watt medals and premiums to Messrs. H. L. Callendar and J. T. Nicolson, B.Sc.; a Telford medal and premium to Mr. A. H. Preece; George Stephenson medals and premiums to Messrs. Whately Eliot and W. O. E. Meade-King; a Crampton prize to Mr. E. W. Anderson; Telford premiums to Messrs. L. B. Atkinson, Henry Fowler and W. L. Strange.

The meeting of the British Association for the Advancement of Science in 1899 will be held at Dover, September 13th–20th. The meeting of the French Association will be held at nearly the same time at Boulogne, so as to enable the two associations to interchange visits. The preliminary arrangements for these meetings have already been made, and Professor Michael Foster will be nominated President for the meeting of the British Association at Dover. The meeting of the British Association in 1901 will be held at Glasgow. An important exhibition will be open in that city at the same time. The place of meeting for the previous year is not yet fixed, but we understand that an invitation to hold it at Bradford, Yorkshire, will be presented to the Association at the Bristol meeting next September.

At a recent meeting of the General Committee of the Philosophical Society, Washington, a special committee, consisting of the President of the Society, Mr. Frank H. Bigelow; the Chairman of the Committee on Communications, Mr. J. H. Gore, and a Past-President, Dr. William H. Dall, was appointed to consider new lines of work and activity appropriate to the usefulness of the Society in the future.

The death is announced, in *Nature*, of Dr. Karl Ludwig Fridolin von Sandberger, who until recently was professor of mineralogy and geology in the University of Würzburg, and Director of the Mineralogisches Institut. Although known for his many important contributions to mineralogical science, to the study of ore deposits and to the microscopic structure of eruptive rocks, he was likewise distinguished for his researches on the fossil Mollusca of various formations in the Rhenish provinces and other parts of Germany. His published works date back to 1847. During the years 1850–56 he issued, in conjunction with his brother, Dr. Guido Sandberger, 'Die Versteinerungen des rheinischen Schichten-systems in Nassau,' a work remarkable for the beauty of its illustrations and the fidelity of its descriptions, and one which was honored by the award of the Wollaston Fund, which was given to the authors by the Council of the Geological Society in 1855. In 1863 Dr. Fridolin Sandberger published 'Die Conchylien des Mainzer Tertiärbeckens;' in 1870–75 he issued, in two volumes, 'Die Land-und Süsswasser-Conchylien der Vorwelt;' and in 1882–85, 'Untersuchungen über Erzgänge,' an authoritative work on the subject of mineral veins. In the course of his long labors he turned his attention to the Mollusca of many different formations, from those of Devonian age to those of Pliocene and Pleistocene deposits. In later years his work became more concentrated on mineralogical science. In 1875 he was elected a foreign member of the Geological Society of London. He was born in 1826, and died at Würzburg on April 11th.

We regret to record the deaths of Dr. Hermann Kämmerer, professor of chemistry at the Industrial School at Nuremberg, on April 12th, at the age of fifty-eight years; of Dr. Samuel Gorden, President of the Royal Academy of Medicine of Ireland, and President of the Royal Zoological Society of Dublin; and of M. Demontzey, Correspondent of the Paris

Academy of Sciences (Section of Rural Economy).

AT the Royal Institution, London, on May 12th, Lord Rayleigh delivered the first of a course of three lectures on 'Heat,' and on May 21st Mr. J. Arthur Thomson will begin a course of two lectures on 'The Biology of Spring.' The Friday evening discourse on May 6th was by Mr. E. A. Minchin, whose subject was 'Living Crystals.'

PROFESSOR H. G. SEELEY, F. R. S., is again conducting the annual course of excursions of the London Geological Field Class, arranged to illustrate the physical geography and geology of hills, valleys and rivers in the basin of the Thames. The following meetings were arranged for the present month: May 7th, Greenwich Park and Charlton; May 14th, Aylesbury; May 21st, Highgate and Hampstead.

A MEETING of the New England Association of Chemistry Teachers was held in the United States Hotel, Boston, on May 14th. There was a short business session and a dinner. Professor Theodore William Richards, of Harvard University, spoke on 'The Aim of the Harvard Requirements in Chemistry.'

THE Horticultural College at Swanley is for the first time opening courses of instruction to non-resident students of both sexes. Courses of lectures will be given during the summer—on 'Soils,' by Professor Warington, of Oxford; the 'Psychology of Plants,' by Professor Henslow, of the Royal Horticultural Society; and on the 'Culture of Flowers and Vegetables,' by the Misses Dean. Classes will also be held in bee and poultry keeping.

THE Russian government has decided to introduce the metric system of weights and measures throughout the Empire, and by order of the Czar a decree to this effect has been submitted to him for signature.

THE steam yacht 'Windward,' loaned to Lieutenant Peary for his Arctic expedition by Mr. Harmsworth, has arrived in New York, fifty-two days after leaving London.

AN electrical exhibition of much interest is now in progress in the Madison Square Garden, New York. Many of the exhibits are chiefly of technical interest, and others are arranged to attract spectators. But the exhibit as a whole deserves the attention of the student of physical science.

WE incidentally noticed last week that a kinematograph of the eclipse of the sun taken by Rev. C. M. Bacon, at Buxar, had disappeared. The London papers announce 'a reward of fifty pounds for the arrest of the person or persons who on Wednesday last stole a kinematograph negative of the last total eclipse of the sun, between the Royal Albert Docks and Egyptian Hall, in Piccadilly.'

THE House of Representatives has passed a bill appointing three commissioners to propose necessary revision of the statutes relating to patents, trade and other marks, and trade and commercial names. The commissioners are to be named by the President, and are to report to Congress such proposed revisions as may appear necessary to make the laws conform to recent international agreements.

AMBASSADOR WHITE has forwarded to the State Department a copy of a note from the German Foreign Office in regard to restrictions placed on United States fruit imported into Germany, from which it appears that the Imperial Chancellor has, in accordance with the opinion of experts, divided plants into three groups, namely: 1. Those absolutely prohibited. 2. Those admitted unconditionally; and 3. Those admitted upon being found free from the San José scale, after examination.

AN extraordinary feat was performed by the engineers of the Great Northern Railway at Hatfield; and by the engineers of the Pennsylvania Railroad, later, a greater feat was performed in the replacement of bridges on those lines. In the one case the replacement of the structure was effected in fifty minutes; in the other instance it required but *two minutes and twenty-eight seconds*. An English technical journal, at the time, asserted that the first statement was 'creditable and credible,' but that the second was entirely beyond belief. The whole story of the second of the two wonderful performances is, however, told by Mr. Joseph Richards, of the A. S. C. E., in a paper

read before the Engineers' Club of Philadelphia, December 4, 1897, and now in type. The method adopted is described and the statement above confirmed. As the English editor says, after reading it and frankly admitting its truth: "It is the old story of Columbus's egg; the thing is very simple when you know how to do it, and American engineers deserve credit for knowing how."

Mr. J. G. Jack is conducting a series of lectures and field meetings at the Arnold Arboretum, Jamaica Plains, during May and June, for the purpose of supplying popular instruction about the trees and shrubs which grow in New England. The lectures are held on Saturday mornings at ten o'clock and on Wednesday afternoons at three o'clock, beginning on Saturday, May 7th, and closing June 25th. The class assembles each day in the lecture-room of the Bussey Institution, where a review is given of certain groups of trees and shrubs. It then adjourns to the Arboretum for an informal out-door study of the plants.

The bill before the Massachusetts Legislature for the promotion of anatomical science, a measure amending the present law relative to the disposal of bodies for dissection, so that the four leading colleges of the State shall have the bodies of paupers from State institutions, unless the pauper requests an ordinary burial, during his last illness, or the same request is made by one of his friends, has been ordered for a third reading by a vote of eighty-three to forty.

The Governor of Hong Kong has reported to the Secretary of State for the Colonies that there have been 609 cases of plague in that colony during the current year. The return is complete up to April 25th, and in the last week which it embraces there were 127 cases, or over one-fifth of the total for the four months. Cultures of bacilli from suspicious cases of illness in Calcutta have been sent to Bombay to be subjected to Professor Haffkine's examination and have been pronounced to be those of true bubonic plague.

It is stated in *Nature* that the Liverpool Marine Biology Committee's Easter party, at the Port Erin Biological Station, included Mr. Isaac C. Thompson, Mr. Frank J. Cole, Mr. R. A. Dawson, Mr. H. C. Chadwick, Professor Herdman, and several students from University College, Liverpool. The Lancashire Sea Fisheries steamer is also at Port Erin, and several dredging and trawling expeditions are taking place. Spawn of several fishes has been obtained and fertilized, and is now developing in the tanks. Under the care of Mr. Chadwick, Curator of the Station, the aquarium is in a flourishing condition, and contains a number of interesting animals, some of which are spawning. A recent addition to the laboratory accommodation at the Station has been completed, which gives five additional work windows for students, so that there is now plenty of room for other workers.

The will of the late Mr. Oliver A. Judson, of Philadelphia, has bequeathed to the College of Physicians of that city $1,000, the interest, whenever it amounts to $100, to be offered as a prize for the best original essay on 'The Practical Prevention of Disease.' The essay must be written in English, but the competition is open to foreigners.

Mr. Bernard Quaritch, London, offers for sale a complete set of the transactions of the Zoological Society, London, beginning in 1833, for £52 10s. The set is very rare and being sold much below the cost of publication would be a valuable addition to many American libraries. A copy of the first edition of Izaak Walton's *Compleat Angler* was sold recently in New York for $240.

The arrangements for laying the cable from Iceland by way of the Faröe Islands have been completed, and the cable will be laid during the summer.

UNIVERSITY AND EDUCATIONAL NEWS.

Owing to demonstrations upon the part of the students, the Universities of Naples, Bologna and Rome have been closed.

The next meeting of the Association of Colleges and Preparatory Schools of the Middle States and Maryland will be held at Columbia University, New York City, N. Y., on Friday and Saturday November 25 and 26, 1898.

Plans have been completed for a new build-

ing for the Jefferson Medical College, of Philadelphia, which will be erected at the corner of Walnut and 10th streets, occupying a space of 118 feet by 107 feet. It appears, from the plans, that very complete arrangements have been made for laboratories, lecture rooms and dissecting rooms.

A DONOR, whose name is withheld, has subscribed $25,000 for Barnard College in case the $100,000 needed to liquidate the debt on the College is subscribed by October 3d. $23,000 had previously been subscribed.

PROFESSOR JAMES SETH, who now holds the chair of moral philosophy at Cornell University, has been elected professor of moral philosophy in the University of Edinburgh, to fill the chair vacant by the death of Professor Calderwood.

DR. CHARLES H. JUDD, Wesleyan University, has been called to a chair of psychology in New York University.

DISCUSSION AND CORRESPONDENCE.

REMARKS ON THE METHOD OF THE 'NEW PSYCHOLOGY' WITH MEMORY.

TO THE EDITOR OF SCIENCE: Dr. Scripture's 'The New Psychology' is an interesting and useful résumé of the results of a certain order of investigation whose value and significance seems at present, however, debatable. The author wishes, and wishes rightly, to reduce psychology to an exact science, but does not science mean a complete and special investigation of the circumstances affecting any phenomenon? Take thus the phenomenon of memory: Does not a scientific study of it require a thorough and special investigation of all factors psychical that affect it, to show their interrelation, and by isolation to show their relative values? Is not this method required of the biologist who studies the phenomenon of cross-fertilization or of the physicist who studies crystallization, and shall we be less rigid for the psychologist who studies memory? Now Mr. Scripture starts out with the assumption that a memory is a function of one element, physical time, and interprets wholly by this factor, lumping all other elements under a mere general reference to 'circumstances' and the 'individual.' It is not to be denied that physical time by pendulum beats has some relation to memory, but Mr. Scripture certainly fails to make clear that he has isolated this phenomenon, which is, moreover, of minor importance. Memory is far more a function of interest than of time, either physical or psychological. For instance, in the experiment detailed (p. 189) the matter of seconds and minutes is not the main determinant of decreasing memory with the experimenter. On the contrary, interest, his interest in accuracy, in success, etc., is the main factor to be investigated, and to study memory without definitely studying interest is like testing speed of locomotives without reference to motive power. That a locomotive moves at certain reduced velocities after certain lapses of time does not imply that time *per se* has reduced velocity in given ratio, but that this ratio is dependent on the initial head of steam, lubricity of parts, etc. Now the motive power of memory is interest, and mere lapse of time operates mainly, at least, merely as allowing room for conflicting interest. It is plain that if in the experiment referred to the agent was influenced by life and death motive, or even by some greatly desired prize, the memory power would be indefinitely strengthened. What very intensely interests us we always remember, and often with increasing vividness, for memories becoming cumulative in effect may reinforce each other so as to more than offset lapse of time. We also note that the aged man recalls the scenes of youth much more acurately and freshly than when he was middle aged. We know also that interest quite reverses the time law in the case of one who after some years absence returns to his former dwelling place, when events and places concerned with his life some time before his absence are recalled with accuracy far greater than if he had had continued residence.

It is certainly very desirable that we should attain to some scientific understanding of the relation of interest to memory, but first we must devise some method of measuring interest. But any real science of memory cannot neglect that by which memory has been originated and developed, namely, interest.

But the whole standpoint of 'the New Psy-

chology' is unpsychological. Psychology is not primarily concerned with the time of sense, but with the sense of time, that is, it is not primarily concerned with the physical or physiological. Hence to make memory merely some simple function of time, as logarithmic, just as we find gravity to vary inversely as the square of the distance, is an enticing but false simplification of psychic act. While the physics of psychology is an interesting if somewhat limited field, it does not deserve the term 'the New Psychology.' 'The New Psychology' is that which has felt the stimulus of evolutionism, and whose standpoint is not physical but biological. The psychic phenomenon is a life method, and thus memory is a function of and for life, a mode of building up experience into a whole which should serve the individual and race as a sort of psychic capital.

Now the failure to take biology as the main standpoint leads to the very unsatisfactory remark (p. 208) that similarity, contrast, etc., are not real laws of association in memory, but only 'schemes for classifying associations,' and that the 'real law' has never been found. That is, we understand that some psycho-physical law yet undiscovered is the real scientific explanation, and the present psychology of memory by laws of similarity, contrast, etc., has little or no value. But appreciation of likeness and sameness, for instance, is of the greatest importance to the living organism, as in recognition of food, mate, etc., and hence it has become a prime method or law of mental organization. Mind in animals and men is not a general exhibition of elemental energy in space and time, but a practical device for the advantage of the individual and posterity; hence the laws of association, as commonly given, are vital laws and real laws of connectivity in mind reaching to adaptation.

We conclude that to come to the study of mind by the way of physics is to come by a back door. While we should certainly try to enter by every door that can be found back, side or front, yet the best, most comprehensive and reasonable view comes by way of the front entrance through biology.

Hiram M. Stanley.

Lake Forest, Ill., April 25, 1898.

THE CAUSES OF NATURAL ARCHES.

To the Editor of Science: The note in your April 22d number regarding the natural bridge in Utah is interesting, but I should like to supplement it by stating another interesting thing, namely, that there are in the great arid region a large number of these natural arches. In the Canyon of Desolation, on Green River, they are particularly common, and from the surface of the river some of them seemed of huge proportions. All I have seen occur in formations exactly similar in kind—homogeneous sandstones with tendencies toward conchoidal fracture—and my observations are against the wind erosion theory as a prime factor.

The beginning appears generally to be in some natural crevice or cleft on the face of the bare cliff wall, where water is able to penetrate and allow frost to start operations by throwing out a fragment that leaves a cavity almost a miniature of the final perforation which marks one further period in the demolition of the cliff. This fragment is followed by many others, till the cavity presents the appearance of an alcove with arched top, and a talus floor. The arch gradually deepens into the cliff, and I have seen one so deep that its floor was a lake, with a grove of trees at the opening. Frequently, if not generally, the deepening is assisted by water percolating from above.

At a certain depth, if the cliff is a thick one, the arch begins to protect itself, and the excavation proceeds more slowly. It becomes a cave with floors of various character according to circumstances that vary with other conditions. But if the cliff is comparatively thin the wearing finally cuts through to the opposite side, and then wind erosion becomes a more potent factor. I have seen many examples of every stage of progress, and I have seen at least one beginning where a rain torrent was in active operation, and made a sketch of it. Frost, and the disintegrating and dissolving power of water combined with structural tendencies, appear therefore to be the chief causes of these natural arch forms.

F. S. Dellenbaugh.

New York, May 3d.

SCIENTIFIC LITERATURE.

Anatomische Litteratur in Amerika. I. Wilder's System der Nomenclatur. Von THOMAS DWIGHT in Boston. Separatabdruck aus Ergebnisse der Anatomie und Entwickelungsgeschichte. Wiesbaden. 1897.

It is now some twenty-six years since Dr. Wilder commenced his crusade against current anatomical nomenclature, and during that time his activity has been great. Firmly imbued with the idea that reform is urgently required, he has been prolific in inventing new terms and urgent in pressing their acceptance upon the scientific public. Although his following has not been numerous, most scholars being repelled by his fantastic terms and his defects of literary form, yet by persistence and iteration he has made himself a veritable force in the anatomical literature of this country, a force that must be reckoned with whenever any question of terminology is to be considered.

The paper here presented to the German reading public by the well known professor of anatomy in Harvard University is an attempt to correct certain misapprehensions that have arisen in Germany with regard to the views of Dr. Wilder and the position he occupies. In order to explain how these misapprehensions arose it will be necessary to touch briefly upon certain matters that, while familiar to those interested in nomenclature, are not widely known to the public at large.

When, in 1889, the Anatomische Gesellschaft, the principal foreign society of anatomists, appointed a committee to consider the subject of nomenclature it was natural that Dr. Wilder should be consulted. Several American scientific societies had appointed similar committees,* and in these Dr. Wilder took great interest, obtaining from them, either directly or indirectly, some brief and very moderate reports not antagonistic to his views. These he forwarded in considerable numbers to the German committee, together with some publications of his own. It seems that he did not at all realize the ignorance that naturally prevails in Germany as to scientific work in this country, and that, although he had no official standing whatever that would authorize him to speak for American anatomists, he created the impression that he represented some American committee that indorsed and supported all his somewhat revolutionary ideas.

Under this misapprehension the Anatomische Gesellschaft made the following formal protest against what they assumed was the American scheme:

"The Anatomische Gesellschaft thinks it ought to take a stand against the attempts of the American Committee on Nomenclature. It recognizes the usefulness of as short names as possible and the aptness of some suggestions which have came from America. It protests, however, against the inconsiderate use of mononyms and the consequent radical remodeling of anatomical language as it has existed hitherto. To follow the American committee in this course is forbidden to the Anatomische Gesellschaft by the acknowledged laws of general language formation as well as by a regard for the historical development of our own science. Should the construction of a peculiar anatomical terminology make progress in America along these lines, an impassable chasm would be formed between those who pursue anatomical studies and those who devote themselves to medicine, and thus coöperation in scientific work would be deeply disturbed."*

Again, when the list of terms adopted by the Gesellschaft came to be published, it was accompanied by some rather tart remarks by Professor His concerning the 'American committee and its very zealous member, Mr. Wilder,' who had 'already published a lot of small papers and pamphlets.'

In consequence of his strictures there ensued a rather acrimonious correspondence between Dr. Wilder and Professor His, in which both parties appear to have lost their tempers, and from which no distinct advantage accrued to science.†

Dr. Dwight proceeds to give an accurate account of the American committees, their recommendations and the official connection of Dr. Wilder with them, showing that they were in no way responsible for his acts and had never recommended the comprehensive remodeling of anatomical terminology that he advocates.

*The American Association for the Advancement of Science, the American Neurological Society, and the Association of American Anatomists.

**Anatomischer Anzeiger*, Ergänzungsheft zum Xte Band, 1895, p. 162.

†Published by Wilder in his Neural Terms, *Jour. of Comp. Neurology*, 1896.

Some of the peculiarities of the Wilder system are then briefly discussed, attention being called to its disregard of the ordinary principles of language formation as exemplified by: 1st. The mutilation of words, as by using 'alinjection,' for injection with alcohol; chippocamp, for hippocampus major, etc. 2d. The substitution of monomial terms ('mononyms,' Wilder) for those sanctioned by long usage and historic precedent. In recent publications we are asked, for example, to say 'restis,' for restiform body; 'praecribrum,' for anterior perforated space; and 'quadrigeminum,' for corpora quadrigemina. In this matter the majority of anatomists will probably agree with Professor His that "the contraction of several words into one may under certain circumstances be an improvement, but as the conciseness of a telegram may lead to its obscurity, so terms used in this way may, from their very brevity, demand a special explanation for their comprehension."* Dr. Dwight cites, with approval, the writer in *Nature* who styles this system a scientific Volapük. Dr. Wilder himself recognizes the necessity for furnishing a vocabulary for his peculiar tongue, as is done with the artificial language just cited, for his longer essays are accompanied by a chapter of definitions, and his shorter ones have numerous parenthetic interpolations for explaining the meaning of his terms.

The degrading influence that such inartistic curtailments must have upon ordinary literary style is pointed out by Dr. Dwight. We notice in a recent publication from Dr. Wilder's pen that 'anatomic teachers' are mentioned, by which grisly term he apparently means teachers of anatomy.

Dr. Dwight suggests that some of the oddities of this system have, doubtless, arisen because of the peculiar isolation of Dr. Wilder from those who are using human anatomy practically and who, therefore, feel the necessity of preserving unbroken the traditions of anatomical speech. Medicine and surgery have never been taught at Cornell University, and Professor Wilder's chair is not that of human anatomy.

The general verdict of foreign anatomists is strongly against these innovations, and is well voiced by the following temperate and wise rebuke administered by the veteran Kölliker, who was Chairman of the Committee on Nomenclature of the Anatomische Gesellschaft:

"I regard the anatomical nomenclature that has emanated from America in recent years as a complete failure, and so inappropriate that it is impossible for me to read articles based thereon. One can hardly ask a scholar who has received a regular training to accept quietly the many barbarisms of this nomenclature, such as *metatela*, *metaplexus*, *auliplexus*, *diaplexus*, *ectocinerea*, *cephalad*, *caudad*, *dorsad*, *cephalo-dorsad*, *ventro-caudad*, *dorso-caudad*, *hemi-cerebrum*, etc., and to turn back and find out the meaning of a great number of other terms, such as *terma*, *proton*, *pero*, *prosoterma*, *diaterma*, *supraplexus*, *aula*, *alba*, *crista*, *diacoele*, *mesocoele*, etc. As the oldest German anatomist, I may, perhaps, be permitted to advise my American colleagues not to proceed farther upon this path lest it might happen that, in the course of a few years, the anatomists on this and on that side of the water no longer understand each other and all scientific interchange of ideas become impossible."*

Dr. Dwight protests against the designation 'American' as applied to the Wilder system, and closes his too brief article as follows:

"As regards the future it may be that an unexpected prophecy may be deduced from its likeness to Volapük. That pseudo-speech has fallen, apparently never to rise again. Whether the Wilder system as a whole will outlive the loss of the great influence and enthusiasm of its author, which must naturally occur in the course of human events, is very doubtful; it is certain, however, that whatever good there is in it will survive beyond that day which we hope may still be far distant."

Frank Baker.

A Description of Minerals of Commercial Value. By D. M. Barringer. New York, Wiley & Sons. 1897. First edition. Pp. 168.

Barringer's 'Minerals of Commercial Value' is a small volume bound in flexible cloth issued

* Die Anatomische Nomenclatur, p. 7.

* Kölliker, A. 'Handbuch der Gewebelehre des Menschen.' 6te Aufl. Band II., p. 814.

for the use of miners, prospectors and business men. From its preface we learn that "the work is intended merely as a book of reference to be used by the practising miner or man of business, for whom especially it is intended, as well as by the geologist, metallurgist or mineralogist in so far as it may serve their purposes. * * * The original intention of the author was to give, in as simple and concise a form as possible, a description of the nature of only the more important of those mineral substances, more frequently referred to as ores or compounds, *which possess commercial value*, indicating at the same time means by which they could be identified, and referring very briefly to some of the principal economic uses to which they are put. Upon reflection, however, it seemed advisable* *to insert also a description of a few other minerals which are very frequently met with as common veinstones or as rock constituents, although they may possess in themselves no commercial value." In short, the book is a work on determinative mineralogy in which, however, only the most important compounds are discussed. There is nothing noteworthy in the treatment of its subject-matter, unless it be the arrangement of the minerals according to their metallic constituent. Whether this manner of arrangement is as good as one based on hardness, density or some other physical property is at least doubtful. Indeed, it is probable the book throughout is too technical for miners, prospectors and business men, though it may easily be of assistance to metallurgists and geologists, more because of its convenient form than because of anything of especial value in its contents.

The first part of the volume contains a list of atomic weights, statements of the characteristics of the crystal systems, the scale of hardness and brief descriptions of the most important blow-pipe reactions and wet tests for the different chemical elements.

The second part is made up exclusively of tables. The minerals of each metal are listed alphabetically and opposite each is given its chemical composition, a statement of its general character and its occurrence, a description of its behavior toward reagents, its color, lustre, etc., and, finally, an account of its uses. In three appendices following the lists of minerals is a condensed form of Brush's classification of minerals according to lustre and fusibility, a list of simple tests for the most important chemical elements and a brief description of the simpler processes of assaying.

The book is carefully compiled and is well printed. It is accurate and therefore trustworthy. Although, as has already been stated, it contains no novel features, it will serve as a convenient companion, because of its handy size, to any one capable of using it. It is the most compact determinative mineralogy in the market.

W. S. BAYLEY.

COLBY UNIVERSITY.

SCIENTIFIC JOURNALS.

The Journal of Geology for February–March, 1898 (Vol. VI., No. 2), contains the following papers: 'Brazilian Evidences on the Genesis of the Diamond,' by Orville A. Derby. The author endeavors to draw a parallel between the geology of the South African Diamonds and of those of Brazil. Three Brazilian localities in Minas Geraes are selected, viz., San João da Chapada, Grão Mogol and Agua Suja. At the first it is uncertain whether the diamonds are derived from phyllites or from contact zones in the phyllites next intrusions of pegmatites, or from the pegmatites. In the second locality they seem to be allothigenic minerals in metamorphosed clastics. At the third place there are basic intruded rocks, more or less analogous to those at Kimberley, but it is still an open question whether the diamonds have been derived from them or from the neighboring schists. Excessive weathering and the present abandoned condition of the Brazilian mines mask the evidence. 'The Glaciation of North Central Canada,' J. P. Tyrrell. The author describes the three successive glaciers of this portion of Canada, viz: 1st, the Cordilleran, that spread from the Cordilleras eastward and then retreated; 2d, the Keewatin, that originated northwest of Hudson Bay and spread north, west, south, and to some degree east, and withdrew; 3d, the Labradorean, that began in central Labrador, spread in all directions, but especially southward, and on the northwest lapped

the Keewatin territory. The relations are illustrated by maps. 'The Use of Local Names in Geology,' C. R. Keyes. The paper is in the main a justification of the recent introduction and spread of local formational names. 'The Weathered Zone (Sangamon) between the Iowan Loess and Illinoian Till Sheet,' Frank Leverett. After an introduction describing the general relationships of the subdivisions of the glacial deposits concerned, the character, distribution and interpretation of the zone of weathered materials, called the Sangamon, are taken up. 'Studies in the Driftless Region of Wisconsin, II,' G. H. Squire. Several small areas are described in detail with sketches, and their topographical forms and superficial deposits are interpreted. 'Fucoids or Coprolites,' J. A. Udden. Fossils closely resembling the *Spirophyton*, of New York, are found in the Middle Devonian along the Mississippi River in Illinois and Iowa. Instead of fucoids, they are interpreted as coprolites from some mud-eating animals, such as sea-cucumbers. 'Zirkelite a Question of Priority,' M. E. Wadsworth. The author introduces, as in other current journals, his claims to priority in the use of the name zirkelite. Significant comments are added by one of the editors of the *Journal of Geology*. Editorials and reviews close the number.

The March number of the *Bulletin* of the American Mathematical Society contains the following papers: 'The Relations of Analysis and Mathematical Physics,' by Professor H. Poincaré, translated by Mr. C. J. Keyser; 'The Roots of Polynomials which Satisfy Certain Linear Differential Equations of the Second Order,' by Professor Maxime Bôcher; 'Inflexional Lines, Triplets and Triangles Associated with the Plane Cubic Curve,' by Professor Henry S. White; 'On the Intersections of Plane Curves,' by Professor Charlotte Angas Scott; 'Euler's Use of i to Represent an Imaginary,' by Professor W. W. Beman; 'Note on the Roots of Bessel's Functions,' by Dr. M. B. Porter; 'Shorter Notices;' 'Notes;' and 'New Publications.'

The April *Bulletin* contains an account of the February Meeting of the Society, by the Secretary; 'The Theorems of Oscillation of Sturm and Klein (First Paper),' by Professor Maxime Bôcher; 'Some Examples of Differential Invariants,' by Mr. Charles L. Bouton; 'On an Extension of Sylow's Theorem,' by Dr. G. A. Miller; 'Note on the Tetrahedroid,' by Dr. J. I. Hutchinson; 'Note on Integrating Factors,' by Mr. Paul Saurel; 'Early History of Galois' Theory of Equations,' by Professor James Pierpont; 'Love's Theoretical Mechanics,' by Mr. W. H. Macaulay; 'Schell's Tortuous Curves,' by Professor Alexander Ziwet; 'Page's Differential Equations,' by Professor Edgar Odell Lovett; 'Shorter Notices;' 'Notes;' and 'New Publications.'

SOCIETIES AND ACADEMIES.

AMERICAN MATHEMATICAL SOCIETY.

A REGULAR meeting of the American Mathematical Society was held at Columbia University, New York City, on Saturday, April 30th. As has now become the rule, the meeting extended through a morning and an afternoon session. In the interval a pleasant opportunity is offered to those present to lunch together in the restaurant on the grounds of the University. Thirty persons were in attendance, and thirteen papers were read, both numbers much exceeding the record of the same season in previous years. At the meeting of the Council seven persons were elected to membership in the Society, and four applications for membership were received. The By-Laws of the Society were amended to provide for life membership, the dues being fixed at $50, exclusive of initiation fee.

The following is a list of the papers presented:

MORNING SESSION.

1. PROFESSOR W. F. OSGOOD: 'Example of a single-valued function with natural boundary, whose inverse is also single-valued.'

2. MR. J. K. WHITTEMORE: 'A proof of the theorem:

$$\frac{\partial^2 f(x, y)}{\partial x \partial y} = \frac{\partial^2 f(x, y)}{\partial y \partial x},$$

3. MR. H. E. HAWKES: 'The limitations of Greek arithmetic.'

4. PROFESSOR H. S. WHITE: 'The construc-

tion of special regular reticulations on a closed surface.'

5. PROFESSOR E. O. LOVETT: 'Infinitesimal transformations of concentric conics.'

6. PROFESSOR E. O. LOVETT: 'Note on infinitesimal projective transformations.'

7. PROFESSOR MAXIME BÔCHER: 'Note on Poisson's integral.'

AFTERNOON SESSION.

8. MR. W. M. STRONG: 'On the necessity of continuity in Euclid's geometry.'

9. PROFESSOR A. G. WEBSTER: 'Note on Stokes' theorem in curvilinear coordinates.'

10. PROFESSOR E. B. VAN VLECK: 'On the polynomial of Stieltjes.'

11. MR. G. P. STARKWEATHER: 'A solution of the biquadratic by binomial resolvents.'

12. DR. G. A. MILLER: 'On the supposed five-fold transitive function of 24 elements and 19!+48 values.'

13. DR. G. A. MILLER: 'On the Hamilton groups.'

The Summer Meeting of the Society will be held at the Institute of Technology, Boston, Mass., on Friday and Saturday, August 19th and 20th, in affiliation with the American Association for the Advancement of Science. A colloquium will be held in connection with the meeting, two courses of lectures being offered by Professor W. F. Osgood, of Harvard University, and Professor A. G. Webster, of Clark University.

F. N. COLE,
Secretary.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 484th meeting of the Philosophical Society was held at the Cosmos Club, at 8. p. m., April 30th. The first paper was by Mr. William Eimbeck on 'Terrestrial Refraction,' as related to the determination of heights by trigonometric processes.

Conceiving refraction to depend solely upon the density of the atmosphere, he showed that it varies not only with the hour of the day, but likewise with the seasons of the year and the heights above the sea, etc. Also, that the diminution of the refraction with heights as exhibited by the coefficients for the various levels of elevation must not be neglected, as is customary in the computation of heights from zenith measures, if the utmost attainable precision is sought. On account of the decrease of atmospheric density, the refraction at a higher station is necessarily always less than at a lower station.

This is a condition, the effect of which is not eliminated by simultaneous measures of reciprocal zenith distances.

The second paper was by E. D. Preston on 'Recent Progress in Geodesy.' After a brief historical review of what has been done thus far in determining the size and shape of the earth, attention was called to some recent measurements of parallel arcs. It was pointed out that both in Europe and America the above measures indicate a smaller radius of curvature than that determined by Clarke's mean figure. The work of the International Geodetic Association was then taken up and a summary given of its recent investigations in the variations of latitude. The fact was noted that it is proposed in the near future to establish four international stations, two of which will be in the United States, and all of which will be within half a mile of the parallel 39° 8′. The most favorable conditions for successful work at these stations were described as well as the mathematical and physical reasons bearing on the choice of location.

E. D. PRESTON,
Secretary.

THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

BY invitation of Dr. C. F. Chandler and the authorities of Columbia University the regular meeting of the Society was held Friday evening, May 6th, at Havemeyer Hall, after a dinner in the University restaurant, at which forty-two members were present. Dr. Chandler made an address of welcome and gave a sketch of the inception and development of the Columbia School of Mines and its successor, the present 'Faculty of Applied Science.' The Chairman then made some remarks expressing appreciation of the invitation from the University, and of the interest in the Section manifested by supplying the entire program of papers, the reading of which was proceeded with as fol-

lows: 1. J. A. Mathews, 'The Action of Nitrils upon Aromatic Acids.' 2. E. H. Hodgson, 'The Determination of Sulphur in Asphalts.' 3. S. A. Tucker, 'A Few Remarks on the Persulphates.' 4. W. D. Engle, 'The Action of Metallic Thio-Cynates upon Organic Chlorhydrins.' 5. A. G. Betts, 'Alcoholic Ethers of Nitro, Amido and Oxy Benzyl Alcohol.'

Mr. Hodgson had determined the sulphur in a variety of asphalts by several well-known methods, one of which was modified by the use of sodium peroxide. He found the following amounts of sulphur and differences by the several methods:

	Nitric acid. (Carius).	Sodium. Peroxide.	Deflagration.
Trinidad Lake.....	4.33	3.77	3.80
" crude.....	4.10	3.33	3.2
" refined	4.46	4.07	3.6
Cuban crude.....	3.61	3.10	2.8
Alcatraz crude.....	5.45	3.98	4.2
California crude.....	7.51	6.26	6.5

In order to have time to inspect the laboratories it was moved and seconded that the last three papers should be postponed to the next meeting, and after passing a vote of thanks to Dr. Chandler and the authorities of the University a tour of the chemical department laboratories was made.

Durand Woodman,
Secretary.

Academy of Natural Sciences of Philadelphia, May 10.

Professor H. A. Pilsbry spoke of certain embryonic or nepionic characters of Bulimulidæ having a bearing on the classification of the group. In the case of some of the young shells a fine grating on the upper whorls comes to a stop where the shell is hatched; in others there is no sculpturing, while in others there are zigzag or equidistant ridges with fine striæ between. These characters can be correlated with peculiarities of the soft anatomy, but not with those of the adult shell. The geographical distribution of the groups thus defined was given, and illustrative specimens of embryonal apices were shown under the microscope.

Professor Pilsbry also made a communication on the results of recent work on the mollusca of Lake Tanganyika and demonstrated the relationship of the halolimic genera to marine forms.

Mr. Joseph Willcox exhibited a fine series of *Cyprœa exanthema* and *C. cervus* to sustain his opinion that these species grade into each other and that *cervus* can scarcely be considered even a variety of the other. He believed the mantle filaments of *Cyprœa* have a direct influence on the formation of spots on the shell, perhaps secreting the light color to which they were due.

Professor E. G. Conklin read a paper on the environmental and sexual dimorphism of *Crepidula*. The conclusion was reached that it is a case of protandric hermaphroditism and of marked sexual dimorphism. The communication was presented for publication and will appear in the *Proceedings* with illustrations.

Papers on certain aboriginal mounds of the South Carolina coast, the Savannah River, and the Altamaha River, by Clarence B. Moore were also presented for publication and will form part of the next number of the *Journal*.

Edward J. Nolan,
Recording Secretary.

NEW BOOKS.

Outlines of the Earth's History. N. S. Shaler. New York, D. Appleton & Co. 1898. Pp. iv+417. $1.75

Brown Men and Women. Edward Reeves. London, Swan, Sonnenschein & Co.; New York, The Macmillan Company. 1898. Pp. vi+294. $3.50.

The Story of Photography. Alfred T. Story. New York, D. Appleton & Co. 1898. Pp. 169.

Electro-Physiology. W. Biedermann; translated by Frances A. Welby. London and New York, The Macmillan Company. 1898. Vol. II. Pp. vii+500. $5.50.

Organic Chemistry. John Wade. London, Swan, Sonnenschein & Co.; New York, The Macmillan Company. 1898. Pp. xvi+460. $1.75.